A STUDY OF THE EFFECTS OF YOGIC EXERCISES ON PHYSIOLOGICAL FUNCTIONS IN YOUNG HUMAN VOLUNTEERS

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CERTIFICATE

Certified that the work entitled "A STUDY OF THE EFFECTS OF YOGIC EXERCISES ON PHYSIOLOGICAL FUNCTIONS IN YOUNG HUMAN VOLUNTEERS" has been carried out by Dr. B.K. Shukla himself in this department.

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This is to certify that the work of Dr. B.K. Shukla entitled "A STUDY OF THE EFFECTS OF YOGIC EXERCISES ON PHYSIOLOGICAL FUNCTIONS IN YOUNG HUMAN VOLUNTEERS" which is being presented by him as a thesis for the award of M.D. (Physiology), has been carried out by the candidate under our guidance and supervision. The techniques employed in this work were actually under taken by the candidate himself and the observations were periodically checked by us.

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INTRODUCTION

INTRODUCTION

India had a glorious past of rich cultural heritage of its people. The antiquity of achievements of Hindus in analytical and creative thoughts is universally acknowledged. When Aryans entered the Indus Valley they brought with them their good culture, philosophy, arts, science and medical knowledge too. In addition they also took over and assimilated many aspects of existing Indus Valley culture. Vedas are the most ancient written records of Hindu culture, arts, science and medical knowledge. Subsequently the knowledge of medicines in medieval India expanded by number of further additions by various Rishis and finally it let to birth a fulfledged science of health known as Ayurveda which involves treatment of various diseases by indigenous drugs. In addition of Ayurveda a different system of medicines which does not involve any medicine but simply practice of a well organised physical posture known as Yoga was also practised by ancient Indians even before the advent of Aryans in the Indus Valley. All the evidence from the archeological studies of the Mohan-Jo-Daro excavation have revealed a seal dating 3000 BC which depicts figure of a deity seated in a yogic posture. This indicates that the Yogasanas (Yogic posture) and discipline of Yoga itself are much older than the Vedas and Upanishads. Although Yoga was existing since a long

time, it was compiled in a systematic manner by Patanjali's Yoga Sutras in 2000 BC.

According to Vedant School of philosophy there are seven different plains or levels (Suptbhumika) of existence of mind. These different plains are also known as centres of chakras. According to Patanjali these chakras are :

1. Muladhara Chakras : Which lies in between genitals and anus.
2. Svadhisthana Chakras : Which lies a little above the Muladhara chakra.
3. Manipura Chakra : Which lies near the umbilicus.
4. Anahata Chakra : Which lies near the Heart.
5. Vishuddha Chakra : Which lies in the neck.
6. Agnya Chakra : Which lies at the level of fore-head between the two eye brows.
7. Sahasrara Chakra : Which lies inside the skull above the palate.

These hypothetical centres or chakras are connected by a large number of channels known as Nadis, among them 15 are quite prominent. They are Sushumna, Ida, Pingla, Gaandhari, Hasth-jihwa, Pusha, Yashwani, Shura, Kuhu, Saraswati, Varuni, Alambusha, Vishyodari, Shankhini and Chitra. Out of these nadis Sushumna, Ida and Pingla are most important from yogic point of view. Sushumna lies centrally which is probably equivalent to spinal canal

and Ida and Pingla lie in the left and right of Sushumna respectively. These three nadis begin their course from a triangular zone (Yonimandal) near the Muladhara chakra and connect other chakras. In addition to these nadis there is another very fine microchannel existing inside the Yonimandal in a coiled manner which is known as Kundalini shakti or surpent power. In normal physiological state the primorial energy (prana shakti) passes through the ida and pingla but in certain special circumstances if the kundalini shakti can be activated particularly by yogic practice and meditation the coiled surpent power becomes straight and enters into Sushumna which normally remains closed. Once Sushumna get opened by surpent power, electrical current passes through Sushumna and activates all the chakras. This is known as arousal of kundalini shakti.

When kundalini shakti reaches Agnya chakra and Sahasrara chakra the individual attains samadhi and during this time the consciousness (chitt) is without any disturbance and does not respond to any external stimulus. According to ancient concept Yoga means to link, to join, to unite. It refers to the union of the impodied prana (vital force) to the universal energy (Maha-shakti) by activating Kundalini shakti with help to Yogic practices and meditation. Yoga has many branches and sub-branches viz. Hatha yoga, Raj Yoga,

Bhakti Yoga, Mantra Yoga, Laya Yoga, Gyan Yoga, Japa Yoga, Ajap Yoga, Kundalini Yoga, etc.

Out of these, Raj Yoga is a practical and fundamental step for the attainment of Samayana. It has been further divided intc Yama, Niyama, Asana, Pranayam, Dhyan, Dharna and Samadhi, the last three together are responsible for the attainment of Samayana, posture (asana) gestures (Mudras) contractions (Bandhas) and rhythmic breathing (Pranayama) are the physiological techniques which quicken the mind.

In this work we have studied the effects of ten yoga postures Muktasana, (wind clearing posture), Bhujangasana (cobra posture), Naukasana (boat posture), Makarasana (crocodile posture) Virasana (hero posture), Uthit padmasana (raised lotus posture), Gomukhasana, (cow posture), Paschimottanasana (posterior stretching posture), Matsyasana (fish posture), Shavasana (corpse posture). Five pranayams, Kapalbhati (skull startling breathing), Mand Gambhir Swasan (simple deep breathing), Ujjayi (victorious breathing), Bhastrika (bellows breathing) Suryabhedi (sun cleaving breathing). Five mudras, Maha mudra (might gesture), Singh mudra (lion gesture), Shakti chalini mudra (energy moving gesture), Vajroli mudra (vajroli gesture), Aswani gesture (horse gesture) and five Bandhas, Uddiyana bandha (gut contraction), Lalandhara Bandha (tracheal contraction), Mula

bandha (anal sphincters contraction), Maha Bandha (great contraction), Maha vedha (great penetration) on physiological functions of 17 male and 11 female medical students of M.L.B. Medical College, Jhansi.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

According to Yoga Sutras of Patanjali, Yoga restrains the consciousness from responding to different form of stimuli. Yoga system advocates the cleaning and purifying the inlets and outlets of the body through six types of exercises (Shatkarama), i.e. neti (cleansing the nasal passages), dhauti (cleansing stomach), vasti (cleansing the rectum and colon), tratake (cleansing the eyes by fixing the gaze on some object without blinking and keeping it fixed until the lachrymal secretion starts flowing freely), kapalbhati (cleansing the nasopharynx and nasal air passage) and vajroli (cleansing the urinary passage), gajkarni, bagi and shankhaprakshalana etc. are other cleansing practises advocated by different authors. After cleansing the body impurities, yoga advocates the performance of physical, moral and psychological practises through yama (abstention), niyama (observance), asana (physical postures), pranayama (breath control), pratyahara (control of sensory perception), dhyana (fixed attention), dharna (contemplation) and samadhi (absolute concentration). Researches have been conducted on almost all these aspects of yoga through out the world.

Vakil (1950) reported that after 56 hours of confinement in a air tight box a yogi lost his consciousness

but on examination he found that even after a long period of hypoxic state the vital functions were not markedly changed. The blood pressure was maintained at 112/70 mm of Hg with heart rate of 80 per minute and respiration 8-10 per minute. Subsequently Satya Narayan Murthi (1958) conducted study on Shri Rama Nand Yogi who claimed to stop his arterial pulses. In a Yogic demonstration it was found that his respiratory rate and heart sounds were not audible, arterial blood pressure was not recordable and planter reflexes were bilaterally flexor without any change in blood sugar, blood urea and plasma electrolyte levels. Although Cardiac sounds were not audible, yet the electrical ativity of the heart was not affected in electrocardiographic analysis.

Anand and Chhina (1960) during a yogic demonstration on those who claimed to stop their heart rate voluntarily observed slowing of heart rate, increase in arterial blood pressure, suppression of alpha activity of the brain on electroencephalogram record and decrease in transverse diameter of heart. Further a detailed study was conducted by Anand et al (1961) on Shri Rama Nand Yogi on whom previously Satya Narayan Murthi had conducted studies in 1958 to see the effect of his yogic miracles while confined in an air tight box. Inspite of decrease in oxygen content and increase in carbondioxide in air

tight box the yogi did not show tachycardia or tachypnea which normally occurs under hypoxic conditions. It was found that the yogi could reduce his oxygen consumption with slowing of heart rate during the confinment. Electroencephalographic records showed changes from alpha rhythm to low voltage fast activity.

From these studies it seems that yogis with the help of their yogic practises could modify the autonomic control of their body including heart. Slowing of heart is a consistent finding in most of the yogic demonstrations. Wenger and Bagchi (1961) investigated four yogis and concluded that yogic exercises could increase the vagal tone of unknown origin. The electroencephalographic effects were variable in contrast to previous findings. Anand et al (1961) observed persistent alpha activity which could not be blocked by sensory stimuli. Rao (1962) estimated the metabolic cost in head-stand posture in six male medical students. Metabolic cost as estimated by the closed circuit. method was 68.6% more in recumbent and 48% more than standing posture. Rao (1963) also studied the cardiovascular responses in erect and head-stand position in healthy male medical students in the age group of 19 to 23 years. He observed that the mean pressure in the posterior tibial artery was increased in erect posture by 98 mm of Hg and heart rate by 17 beats per minute. A slight fall in the mean brachial

arterial pressure was also invariably noted. A change from exact to head stand posture had the reverse effect. The heart rate was now reduced by 15 beats per minute. The mean brachial artery pressure rose by 15 mm Hg, the posterior tibial systolic pressure fell steeply by 19 mm Hg while the posterior tibial diastolic pressure in all the subject was unrecordable. Digital blood flow also showed a tendency to alter with the various postures.

In 1964 Miles observed on an Indian who practised three yogic type of breathing patterns, an oxygen consumption of plus 8% to 32% in Ujjayi + 10% to 14% in Kapalbhati + 17% to + 20% in Bhastrika. Vahia (1966) studied the effect of Yogasana, pranayama, dharna and dhyana on psychiatric patients suffering from schisophrenia. They showed an improvement. Ram Murthi (1967) suggested a methodology of yoga which helped to attain concentration and control of mind.

Rao et al (1968) studied the role of low altitude and high altitude on oxygen consumption during yoga type of breathing and he found that oxygen consumption increased at both altitudes. Chhina et al (1968) investigated eight meditative and one hatha yogi and observed well modulated alpha activity in one of these yogis without being blocked by any sensory stimuli. In 5 yogis they observed marked alpha activity which could not be blocked by external sensory stimuli and one yogi

showed low voltage fast activity. In most of the yogis decrease in respiration, heart rate and blood pressure were observed.

Karambelkar (1969) studied the effects of 20 yogic asans in 15 male and 5 female students attending the three week training. He observed that uropepsinogen was significantly reduced in 13 male subjects. In female no significant changes were observed. Datey (1969) studied 47 patients of essential hypertension who practised 'Shavasana' and observed an improvement in 52% of the hypertensive cases.

Wallace (1970) studied the effects of transcendental meditation on 15 normal young students whose practice of technique had ranged from 6 months to 3 years and observed decrease in oxygen consumption and heart rate during meditation along with increased skin resistance. The electroencephalographic record showed increased amplitudes of alpha waves, occassionally changed to a slower alpha wave frequency and in some cases stopped for 2 to 5 minutes and low voltage theta wave predominated. Bhole (1970) studied two groups of 24 each. One acted as control other practising yogic exercises for period of 3 weeks. He observed that the vital capacity increased in test group from 3.095 litres to 3.132 litres.

In 1971 Wallace et al reported a marked mental and physical relaxation following meditation in 8 subjects.

Oxygen consumption decreased by 20% without changing respiratory quotient and the electroencephalogram showed increased alpha and theta wave activity. The blood lactate decreased and skeletal muscle blood flow increased. Lal et al (1971) studied the effect of pranayama on 10 novices who had registered for 3 month course of Raj yoga and observed decreased heart rate and respiratory rate. Wallace (1971) also noted hypometabolic physiological change other than those occuring during sleep and hibernation in 36 subjects. During meditation oxygen consumption decreased along with decrease in carbondioxide elimination. The arterial pH and blood lactate decreased slightly. The skin resistance increased but the diastolic and mean arterial pressure remained unchanged. The electroencephalogram showed increase in intensity of slow alpha wave and occasional theta wave activity.

Udupa et al (1971) observed in 12 young normal male volunteers undergoing a course of yogic practises for a period of six months, besides a reduction in body weight, a significant improvement in the pattern of respiratory functions viz. lowered respiratory rate, increased chest expansion, increased vital capacity and breath holding time. The metabolic assessment showed enhanced adrenocortical activity, reduction in serum cholesterol, reduction in fasting blood sugar and

restoration of serum protein levels.

Udupa et al (1972) conducted physical, endocrine metabolic and neuropsychological study in a group of 12 young normal male volunteers undergoing a six months course of hath yoga and observed reduction in body weight, respiratory rate with increased chest expansion, vital capacity and breath holding time. An endocrine and metabolic assessment showed enhanced adrenocortical activity, reduction in serum cholesterol level, reduction in blood sugar level and increased serum proteins along with significant increase in urinary excretion of testosterone. A neurohormonal and psychological study showed lowered neurohumoral activity, decreased neuroticism, lowered rate of mental fatigability, increased performance quotient and improved memory quotient. Electroencephalographic study showed prominent alpha waves with fewer spikes indicating a less irritable nervous system.

In 1973 Gopal et al studied the effects of Pranayam on blood pressure, pulse rate and some respiratory functions on 14 trained and 14 untrained persons be observed that in trained persons the vital capacity and tidal volume increased with decrease in respiratory rate, pulse rate and diastolic blood pressure. Udupa et al (1973) subjected a group of normal male volunteers undergoing a six months course of yoga practices and

observed decreased neuroticism index, lowered mental fatiguability index, increased performance quotient improved memory quotient and psychological stability.

Kothari et al (1973) reported various physiological observations after 8 days of confinement in an air tight pit by a yogi who claimed to have attained samadhi. They found that soon after the yogi entered into the pit the heart rate was increased to 250 per minute without any sign of ischaemia. Suddenly after 29 hours the electrical activity of the heart stopped and returned to normal after about a week of confinement. After coming out of the confinement of the 8th day it was found that his body weight, blood pressure, pulse rate, respiratory rate, body temperature and blood sugar were decreased. There was an increase in oral temperature, erythrocyte sedimentation rate, packed cell volume and total leucocyte count. Bhatnagar et al (1973) studied the lung volumes and capacities in 260 subjects of either sexes belonging to different age groups and observed that all the lung volumes and capacities were much lower in female than male except percentage value of F.E.V. where no significant difference was noted.

In 1974, Mookherjee found lowering of heart rate, respiratory rate, blood cholesterol level, blood sugar level and rising of lymphocyte count of subjects practising yoga. Lobo et al (1974) found prolongation of

inspiration time and lowering of respiratory rate and heart rate following 6 weeks of intensive hatha-yoga practise; Bhatnagar et al (1974) found improved thermo-regulatory adjustment, increased oxygen consumption with decrease in ambient temperature, observations in confirmity with those of Green on Swami Rama and Wallace (1974) has described the effects of transcend-ental meditation. As per his observations oxygen consu-mption and metabolic rate markedly decreased (indicating a state of deep rest) but the partial pressure of oxygen and carbondioxide in the blood remained essentially constant. Thus the decrease in total oxygen consumption was not caused by a manipulation in breathing pattern or forced deprivation of oxygen, but is a natural physi-ological change due to lowered requirement for oxygen by the cells during this effortless process; breath rate decreased significantly indicating a more relaxed and rested state of the nervous system.

He further observed that cardiac output markedly decreased indicating a reduction in the work load of the heart; concentration of blood Lactate markedly decreased; skin resistance increased indicating deep relaxation, reduction of anxiety and emotional distur-bances; EEG showed a state of alertness along with a restfulness indicating that while the body is in a state of deep rest, the mind is in a state of inner

wakefulness and alertness; there was an increase in the growth rate of intelligence, increased improvement in recall ability, improved academic performance, more job satisfaction, more stability in their jobs, greater increase in job performance, more rewarding and productive interpersonal relationship in business and co-workers, there was more developed personality increased inner control and decreased anxiety improved psychology, normality, mental health, psychological health, self actualization and decreased blood pressure, reduced use of alcohol and cigarettes, faster recovery from sleep deprivation, a state of integration of emotions and thinking amongst prisoners, reduced use of non-prescribed drugs, improved ability to focus attention, improved resistance to disease by strengthening immune system and regenerative capacity of gums and cessation of allergies, relief from insomania, improved strength, orderliness of brain functioning, thinking, athletic performance, neuromuscular integration, agility, cardio-vascular efficiency, vital capacity and normalization of weight.

Tebecis (1974) has observed that through transcendental meditation there was lowered beta dansity, decreased REM, lessened ocular motility, increased skin resistance and decreased forehead skin temperature; Abravanel (1974) observed an increased mental alertness, autonomic

stability and coherence of physical and mental functions during TM, thus consistently implicating the hypothalamus; Domash (1974) has described macroscopic quantum model of TM and according to him, the physiology of TM is seen as a purified, expanded, isolated version of the characteristic physical property of life in general; Udupa et al (1974) described effects of asana, pranayama and meditation. After 6 months of asanas, they found significant increase in vital capacity, increase in breath holding time, decrease in the rate of respiration and heart beat, notable reduction in body weight, blood sugar and serum cholesterol, their rate of urinary excretion of corticosteroids and testosterone increased and there was improved alpha pattern in EEG; the volunteers practising pranayam showed significant improvement in respiratory functions, improved adrenocortical functions and other allied biochemical changes; those practising meditation showed significant reduction in plasma cortisol, urinary corticoids and urinary nitrogen excretion and there was a significant increase in the blood level of different neurohumors and the related enzymes.

Bhatnagar et al (1974) found lesser heart rate respiratory rate and increased tidal volume and peripheral blood flow in volunteers trained in hatha-yoga discipline; there was a reduction in weight and

subcutaneous fat and an increase in chest circumference; there was an increase in ispiratory reserve volume but vital capacity, MVV pulmonary reserve, percent pulmonary reserve PEVI and chest circumference increased progressively to a considerable extent; blood flow through muscles and skin showed a fall and then a secondary rise, a better thermoregulatory adjustment, improved relation of impulse in the motor nerve of persons trained in hatha yoga were other observations; Dhanraj et al (1971) found a significant increase in BMR and thyroxine content and there was some improvement in oxygen consumption with moderate increase in hemoglobin, hematocrit and red blood cell count.

Bhole (1974) described pressure changes during different phases of pranayamic breathing; He further described pressure changes in oesophagus, stomach, bladder and colon and found that negative pressures developed in both uddiyana and nauli, there was greater speed of water suction in bladder during vauli. Gharote (1974) described significant achievement in the physical fitness following a short-term yogic training in forty border students; Gitananda (1974) described a remarkable reduction of active spermatozoa immediately after the practice of six special mudras called CLI MUDRAS, thus offering a yogic method of family planning; Riga (1974) believed that yoga will become the basis for physical and moral

self-improvement of contemporary and future humanity and Yadav (1974) pleaded for right type of research on yoga. Gode et al (1974) also found increased urinary excretion of testosterone similar to observations of Udupa and other observations on Hatha Yoga were those of Neuhausser et al (1974).

In 1975, Patel found out statistically significant reduction in blood pressure following psychophysical relaxation exercises for 13 months; Nayar (1975) found highly significant increase in breath holding time from 54 to 106 seconds and vital capacity from 1.98 to 2.189 L/M^2 body surface area and forced expiratory volume (from 1.69 to 1.94 litres/M^2 body surface area) and a significant decrease in pulse rate during combined operation of routine National Defence Academy and Yogic exercises; Udupa et al (1975) studied the effects of Shirshasana and Sarvangasana (15 to 18 minutes daily) Bhujangasana and Matsyasana (3 to 4 minutes) and Halasana and Paschimottana (5 to 6 minutes) for a period of 6 months and found a considerable improvement in cardiorespiratory functions, adrenocortical functions and a number of metabolic corrections in addition to a remarkable psycological and neurophysiological improvements. It has been postulated that these changes might be due to the specific rehabilitative effects of the Yogic practices on different vital organs

improving their microcirculation and thus improving their functions.

Suryanamaskara, on the other hand, influences the skeletal muscles only without any increase in serum PBI and plasma cortisol which could indicate improved thyroid and adrenocortical functions. Sarvangasana group showed maximum increase in serum PBI which suggest that this particular asana rehabilitates the thyroid gland. The Suryanamaskara appears to induce mainly a stressful state as is evident from the increased levels of neurohumors and related enzymes in contrast to yogic practices which appear to exert neurophysiological stability as is evident from lowered level of cholinesterase and catecholamines.

Salgar et al (1975) had suggested application of padmasana in conditions of low cardio-respiratory reserves; Udupa et al (1975) had found pranayama a comprehensive respiratory exercise capable of inducing a number of systemic effects besides causing improvement of respiratory functions; Udupa et al (1975) have found out that sarvangasana induced prominent (1975) physiological effects specially in cardio-respiratory system with least amount of physical changes produced some improvement of endocrine and metabolic effects. Shirsasana and Halasana on the other hand produced more of physical effects and lesser amount of physiological

changes; Udupa et al (1975) had further found some significant biochemical changes following a 10-day course of meditation. The blood neurohumors and the related enzymes, namely RBC cholinesterase, plasma catecholamines and plasma histaminase were found decreased. This indicated that after the course of meditation, these subjects were physically stable and were under less stressful state while they were mentally more active and were in a state of increased awareness. Deutsch (1975), Schuster (1975) and Wilson (1975) had tried to elaborate the role of transcendental meditation in relief of bronchial asthma.

In 1976, Bhatnagar et al had studied the effects of Ardha and poorna navasana, poorna shalabhasana, chakrasana and gomukhasana and found an increase in blood flow (wrist and finger) and a significant decrease in the activity of the muscles during the performance of an individual asana particularly in the later months of training; Bhatnagar et al further studied the effects of pranayama like kapalbhati with and without bandhas, bhastrika with and without bandhas and sahaj pranayam and found an increase in blood flow (wrist and finger) and depth of respiration as the training progressed; Balogh (1976) had suggested the use of yoga for the west; Belaia et al (1976) had described certain beneficial effects of few asanas on the central nervous and

cardiovascular system; Gharote (1976) had described the effects of yogic exercises on failures on the krausweber tests and Wigley (1976) had described yoga as a therapy for community psychiatric nursing.

In 1977 Suresh et al conducted a comparative study of pulmonary function tests in bronchial asthma with normal cases and observed that FEV_1 was a reliable index for assessing the therapeutic efficiency of pranayamic exercises. Agarwal et al (1977) observed that more than 25% of medical students under study were hyperreactor to cold pressure test. Hyperreacter were selected for further study and divided into two groups. In the group I, practising shavasana for a period of 3 months a significant lowering of pressure response both systolic and diastolic to cold pressure test was observed. Mental stress always raised blood pressure but stress in persons practising shavasana raised blood pressure to a lesser extent, similarly rise in serum cholesterol level due to mental stress was also raised to lesser extent than the control group. Misra et al (1977) studied the effects of 10 yogic posture on 20 female medical students and observed that there was a significant lowering of heart rate, blood pressure, blood cholesterol level and an increase in lymphocyte count and score in Harward step test.

Karambelkar et al (1977) studied the short term yogic training on serum cholesterol level in 32 subjects of either sexes for a period of 3 weeks and observed reduction in serum cholesterol level in male subjects. This change was highly significant with subjects having high initial cholesterol level, while there was no significant change in case of subjects with normal initial level. In the case of female the results in every respect showed similar trend, though it was not statistically significant. Bhole et al (1977) studied the effect of yogic treatment on breath holding time in Asthmatics and observed that the pranayama and some of the internal cleansing process like Kalpelbhati and Neti increase the breath holding time of Asthmatic patients after one month yogic treatment.

In 1978 Bhatnagar et al studied the effects of yoga training on thermoregulation in 20 subjects and took observations after first, third and sixth months. They found that mean skin temperature (TS) followed the changes in the ambient temperature (Ta) but the core temperature increased very little even during exercise, and this increase was almost negligible after about 3 months of training, suggesting an improved thermoregulatory adjustment. The oxygen consumption increased with decrease in Ta. In some subjects there was a relative decrease in sweat loss inspite of an increased humidity. The increase

in blood flow through muscles and skin as a result of execise showed a similar pattern as observed by workers. However, in about three months of training, this increase had lessened with a concomittant increase in the extraction of oxygen, showing thereby an increased adaptation by yoga training.

Chhina et al (1978) studied the effects of two types of pranayams, one with a faster rate of breathing (Kapalbhati) (for 3 to 5 minutes) and the other with a slower rate of breathing (ujjayi 15 minutes) in ten subjects and studied their effects on EEG and cardiorespiratory functions. Most of the subjects showed alpha activity in their resting EEG records which increased further in amplitude and percentage time by both the pranayamic exercises. The effect persisted for 3 to 8 minutes even after the termination of the pranayam. The subjects claimed to acquire better concentration and mental activity and greater alertness after the pranayamic practices. The effect seemed to be similar to that of meditation and mights have similar underlying mechanisms.

Lakshmikanthan et al (1972) studying the effects of yoga on heart concluded that shavasana and ramkarni were likely to be useful for the treatment of high blood pressure, rehabilitating a patient after heart attack because in addition to giving rest to heart, it

improved the cardiac performance. In viparitkarni sarvangasana and halasana, the work of the heart was increased. In yoga experts and healthy volunteers, the work of the heart was increased and the cardiac performance was improved. Similarly these asanas might be helpful in the primary prevention of ischaemic heart disease. In cardiac patients with subnormal cardiac functions, viparitkarni and sarvangasana increased the work of heart with decreased cardiac performance.

Maini et al (1978) studied the effect of combination of yoga pranayam in 40 medical students and pranayam along in another group of 40 students and found a decrease of fasting plasma glucose concentration by 8% from control. The postprandial changes in plasma glucose with 100 gm load showed a 9% lesser increase than pre-training period. Serum cholesterol decreased by 9-10% in all cases practicing combined training and only in males carrying out pranayams alone. Haemoglobin concentration was significantly raised in all the subjects of both groups by 6 to 10%. No significant alteration in leucocyte count appeared. The absolute eosinophil count declined remarkably (12-23%) in volunteers doing combined training whereas no change occured in individuals carrying out pranayams along. Maini et al (1978) studied the effects of yogic postures on some physiological parameters and found an increase in height,

weight and chest expansion in majority of cases. Heart rate was decreased in 50% of cases; blood pressure was decreased in 50%, increased in 20% and there was no change in 30% of cases; there was an increase in respiratory volume and capacities and improvement in cardiac and respiratory efficiency whereas changes in blood sugar and cholesterol were variable.

Meti et al (1978) studied the value of yoga therapy in the treatment of bronchial asthma in 10 male and 2 female patients in 20 to 55 age groups. The duration of the disease ranged from 1 to 14 years and the treatment period varied from 20 to 100 days. Yoga asanas and pranayamas were performed by them. Bronchodilators were given for a few days after admission and tapered off and afterwards were administered only if patient had moderate to severe attacks. Two females and one male were asymptomatic and remained so. There was good response in one, satisfactory relief in two, partial relief in three and no relief in the remaining three. Patkak et al (1978) concluded that healthy elderly men performing pranayams preserved their body in better form, remained more proportionate with better respiratory functions and stronger grip strength than control group.

In 1979, Lakshmikanthan et al studied long term effects of yoga on hypertension and/or coronary artery disease in 43 males and one female. They were divided

into 3 groups, Group I consisting of 10 patients with established systemic hypertension, Group II of 17 patients with hypertension and Group III of 17 patients with coronary artery disease alone. Hw observed that there was significant decrease in systolic and diastolic blood pressure in group I and II only the triple product in group II and III indicated a rise in anginal threshold and improved effort tolerance and cardiac performance. Bhatnagar et al (1979) studied the thermoregulation and neuromuscular excitability in yogi and noted that hathyogis were able to adjust better to the variation of cold and heat. Some of them could even consciously vary the temperature of the two parts of their body.

Chhina et al (1979) studied the effect of pranayam and observed that in yoga controlled breathing was not only meant for changing the primary functions of lungs for ventilation but also for a gradual training of individual to concentrate on the process of breathing by providing additional help in physical and mental relaxation. Mayer et al (1979) studied on 30 healthy subjects. The subjects were divided into two groups of 15 each. Group I was treated as control and group II practised yogic exercises one hour daily for a period of six months. He observed a gradual shift of autonomic balance towards parasympathodominance, improvement in thermoregulatory efficiency, orthostatic tolerance and lung functions.

In 1980, Tulpule et al studied in 102 male patients of myocardial infarction for a period of one year. All the patients received medical treatment whereever, necessary and indicated. Very simple yogic posture and pranayam were practiced. He observed that yogic posture did not change the basal status of patient and did not produce cardiac decompensation or precipitate angina. Effects on mortality showed that out of 102 trial patients only 3 died during one year of follow up whereas 13 out of 103 died in the control group, and symptoms were better controlled in trial group. Shrikrishna et al (1980) studied the effects of pranayama in 5 subjects trained to perform Ujjayi and Kapalbhati practice daily for 15 minutes for 3 months. He observed that Kapalbhati produced increase in heart rate, mean arterial blood pressure and of alpha index in electroencephalogram. The magnitude of increase in Ujjayi was smaller as compared to Kapalbhati. Kapalbhati produced a decrease in blood glucose level and increase in free fatty acid as well as triglyceride level.

Sachdeva et al (1980) studied the effect of yogic exercise on 20 young healthy subjects. He studied the yogic training for a period of 3 months and observed decrease in systolic and diastolic blood pressure, and increase in finger blood flow. Harward step up test showed an improved physical efficiency. Tidal volume,

minute ventilation respiratory rate and breath-holding time did not change. The basal oxygen consumption was lowered by 20-25%. Begga et al (1980) studied the effects of transaicendental meditation and yoga practice on medical students. He observed that the respiratory rate was the first parameter to decrease. Similarly observations were recorded in practice of shavasana. Gore et al (1980) observed during the study that the increase in heart rate during the Paschimottan (6.2%) was minimum in comparision to increase in isometric (31.8%) and isotonic (13.2%) type of exercises. Rao et al (1980) measured the blood glucose levels in relation to yogic breathing exercises in 25 normal volunteers and 12 confirmed diabetic patients for a period of 3 months. He observed 18 out of 25 volunteers and 8 out of 12 diabetic patients showed a significant decrease in their blood glucose value.

Much work has been done on yoga but a more concerted and methodical approach is still needed on this budding scientific curiosity as this will not only give results of applied value but will also go a long way in unravelling the brain mechanisms for higher mental functions. More accurate biochemical, biophysical and neurobiological changes should be linked to performance of various yogic techniques and it should be ascertained if this practice is of preventive importance only or of curative value also.

MATERIAL & METHODS

MATERIAL AND METHOD

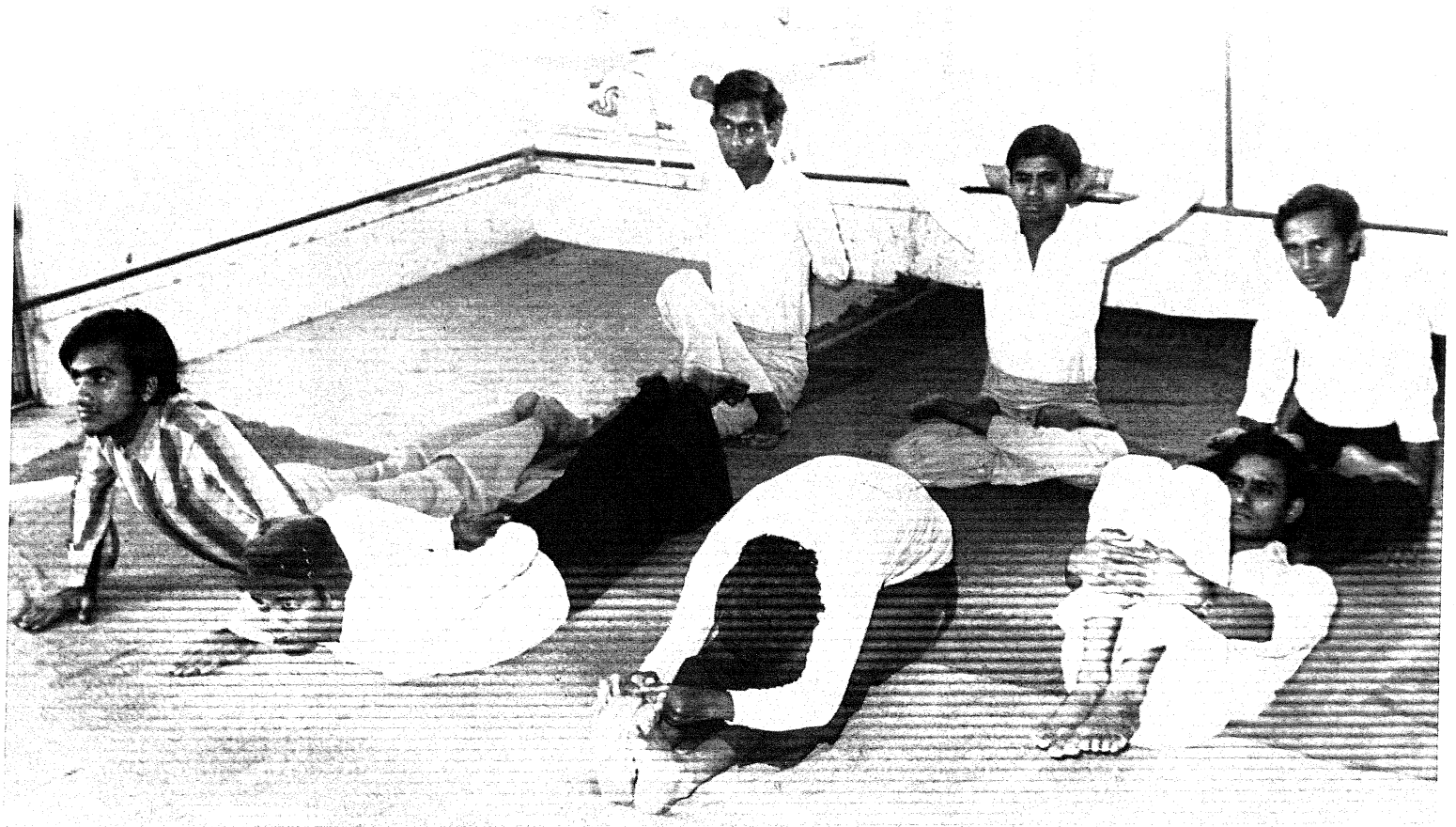
The present study was carried out on 24 male and 11 female, normal, healthy, young medical students of M.L.B. Medical College, Jhansi. During the progress of study 7 male students dropped out and finally study was conducted on 28 students out of which 17 were male and 11 female within the age group of 18 to 23 years. Physiological, Haematological and Biochemical parameters were measured initially. The yogic training was given under the supervision of an yogic expert. These volunteers were subjected to practice 10 asanas, 5 mudras, 5 pranayamas, and 5 bundhas regularly for one and half hour daily in the evening for a period of 3 months. The observations were recorded after 1 month, 2 months and 3 months periods.

Following yogic exercises were performed in each case :

YOGASANAS (POSTURE) :

1. Muktasana (Windclearing posture) :

The students were asked to lie supine and then to bring their legs closer to abdomen followed by grasping their knees with their hands. Then they performed rolling and side to side movements (in fig. No. 1 on extreme right in front row).



2. Bhujangasana (Cobra posture) :

The students were asked to lie prone with their muscles completely relaxed and hands bent at the elbow with the palms embracing the ground. The soles made to look upward. This was followed by raising the head with the neck bent backward as far as possible. Then they pressed hard on hands and raised their shoulders as high as possible with abdomen in contact with the ground. This asana in the initial phase was maintained for 30 seconds and then the duration was gradually increased to 2 minutes (in Fig. 1 on extreme left in front row).

3. Naukasana (Boat posture) :

The students were asked to lie supine keeping their hands on back, palms grapsed to one-another and then asked to raise head and chest as much as possible, and to raise legs as well without bending them at knee joint. The maximum duration for which this asana was performed was two minutes (in Fig. 1 front row second from left).

4. Makarasana (Crocodile posture) :

The volunteers were asked to keep their head on hands in supine position and then to keep legs as apart as possible. The duration for which it was performed was 2 minutes.

5. Virasana (Hero posture) :

The volunteers were asked to sit in an upright posture with legs crossed, left foot was under the right thigh and right foot was over the left thigh, clutching the hands beneath the head and then stretching the body. Maximum duration for which this posture was maintained was 2 minutes (in Fig. 1 middle of back row).

6. Uthit padmasana (Raised lotus posture) :

The volunteers were asked to sit crossed legged with right foot placed on the left thigh with sole facing upwards. Similarly left leg was placed on the right thigh with sole facing upwards. Then both the palms were placed on the ground and pressed hard against it so as to lift the whole body above the ground with the legs held in Padmasana and maintained for 2 minutes (in Fig. 1 on extreme right in back row).

7. Gomukhasana (Cow posture) :

The volunteers were told to kneel cross-leged, feet pointing outwards with medial border on floor, sole facing backwards and knees wall apart. Then they were told to lower themselves gently till the buttocks touched the ground between the feet. Then they raised right hand and brought it over the right shoulder with left hand behind the back griping the fingers and then pulling. The hands were reversed and pulled again. This

was performed for 2 minutes (in Fig. 1 on extreme left in back row).

8. Paschimotansana (Posterior stretching posture) :

The volunteers were asked to sit with their legs stretched infront and then to hold fingers of the feet with their hand and lower the body so as to touch the forehead with the knees. This was performed for 30 seconds to 1 minute (in Fig.1 front row second from right).

9. Matsayasana (Fish posture) :

The volunteers were told to assume the Padmasana then asked to hold both the great toes with hands and then to lie supine. This was followed by raising the chest and abdomen above the ground as much as possible and simultaneously extending the neck to the maximum limit. This asana was performed for 2 minutes.

10. Shavasana (Corpse posture) :

The volunteers were asked to lie supine with arms outstretched and parallel to the body and then were asked to relax the musculature of the whole body and simultaneously to undergo mental and emotional relaxation. This was performed for 2 minutes.

PRANAYAM (RHYTHMIC CONTROL OF BREATHING)

1. Kapalbhati (Skull startling breathing) :

The volunteers were asked to sit in Padmasana and breath in and out rapidly without expanding the chest,

contracting the muscles of the stomach forcefully at each expulsion. This manouver was performed for 10 to 15 times, followed by pause and repeat it for three times. (in Fig. 2 middle of back row).

2. Nand nambhir swasan (Simple deep breathing) :

Volunteers were told to sit in Padmasana or Sidhasana close the right nostril with their right thumb, inhale the air through left nostril till they count 3 oms aloudy. Then asked to close left nostril with the little and ring fingers of their right hand and were now asked to retain the breath till they counted 12 Oms, then to remove the right thumb and exhale through the right nostril till they counted 6 Oms.

3. Vijayi (Victorious breathing) :

The subjects were told to sit in Padmasana to close the mouth and inhale aloudy through both the nostrils in a smooth and uniform manner. They were asked to retain the breath as long as they could do it comfortably and then to exhale slowly through the left nostril by closing the right nostril with right thumb. Next they were asked to expand the chest when they inhaled. During inhalation a peculiar sound was produced owing to partial closure of the glottis. Sound produced during inhalation should be of mild and uniform pitch and of continuous character. Similar five rounds were performed (in Fig. 2 front row on extreme left).

4. Bhastrika (Bellows breathing) :

Volunteers were made to assume Padmasana close the mouth inhale and exhale quickly 20 times like bellows constantly dilating and contracting the chest as they inhaled and exhaled. During this course a hissing sound was produced. Then they were told to expire forcibly following one another in rapid succession. After 20 such expulsions they were asked to make a deep inhalation and retain breath as long as they could do it comfortably and then expire slowly. It was performed for three times (in Fig. 2 middle of front row).

5. Surya Bhedi (Sun cleaving breathing) :

The volunteers were told to sit in Padmasana to close the eyes, keeping the left nostril closed with their right little and ring fingers, slowly inhaling without making any sound as long as they could do it comfortably through the right nostril, then they were asked to close the right nostril with the thumb and retain breath by firmly pressing the chin against the chest (Jalandhara Bandha) and to hold the breath till perspiration oozed out from the root of the hairs (hair follicles). Volunteers were made to gradually increase the period of kumbhaka. Then asked to release Jalandhara Bandha and exhale very slowly, without making any sound through the left nostril with the thumb closing right nostril. It was performed for three times.

MUDRAS (GESTURES) :

1. Maha Mudra (Might gesture) :

The students were told to press the anus carefully with the left heel, stretch out the right leg than catch hold the toe with the two hands, inhale and retain the breath. Then asked to press the chin against the chest firmly (Jalandhara Bandha), and fix the gaze between the eye brows, and to retain the posture as long as they could and than asked to exhale slowly. They were told to practice first on left leg and then on right leg (in Fig. 2 front row on extreme right).

2. Singh Mudra (Lion gesture) :

The volunteers were asked to kneel and sit back on heals, place the hands on thighs just above the knees and inhale deeply then they were asked to lean forward and open mouth widely and say 'Ha' loudly with tongue remaining stuck out as far as possible. It was repeated half a dozen times. While saying 'Ha' the volunteers were instructed to raise their heads from below upwards, (in Fig. 2 back row on extreme left).

3. Shakti chalni Mudra (Energy moving gesture) :

The volunteers were asked to sit in Padmasana and to draw in air forcibly and to join it with apana. Then they were asked to perform mulabandha till the vayu entered the Sushumna. Then they were asked to contract their anal sphincters. After 30 seconds they were asked to release the bandha.

4. Vajroli Mudra (Vajroli gesture) :

The volunteers were asked to sit in Padmasana and to contract and relax the anal sphincters in succession this was performed for 2 minutes.

BANDHAS (CONTRACTION) :

1. Uddiyan Bandha (Gut contraction) :

The volunteers were asked to expire forcibly through the mouth and empty the lungs then they were asked to contract and draw up the intestines above and below the naval towards the back, so that abdomen rested against the back of body high up in thoracic cavity. This was performed 5 times.

2. Jalandhara Bandha (Tracheal contraction) :

The volunteers were instructed to contract the throat and press the chin firmly against the chest after inspiration. This was done 5 times.

3. Mul Bandha (Anal sphincter contraction) :

The students were told to press the anal sphincter with the left heel, keep the right heel pressed at the space just above the organ of generation. Then asked to contract the anus and draw apanavayu upwards. This was performed for 2 minutes.

4. Maha Bandha (Great contraction) :

The subjects were asked to press the anus with the left heel, place the right foot upon the left thigh. Then they were asked to contract the anus and muscle of

perineum, thus drawing the apanavayu upwards, drawing the breath slowly and retaining it by Jalandhara Bandha as long as they could. Then they were told to exhale slowly practice. First on the left side and then on the right side.

5. Maha Vedha (Great penetration) :

The volunteers were told to sit in Maha Bandha posture, asked to draw the breath slowly, retain the breath and press the chin against the chest. Place the palms on ground, rest the body on them and then raise the buttocks slowly and strike them gently against the ground. This was performed for 2 minutes.

The following physiological, haematological and biochemical parameters were recorded initially and in the subsequent follow up at one month, two months and three months duration.

PHYSIOLOGICAL PARAMETERS :

Height :

The height of each candidate was measured with the aid of staedio meter upto 0.1 cm.

Weight :

Weight of each volunteer was taken with help of beam-balance type of weighing machine and the reading were noted up to 0.1 kg.

Surface Area :

Body surface area was calculated from height and

weight in square meters with the help of Du-Bois chart (Hock 1976).

Blood pressure :

This parameter was recorded by mercury sphygmomanometer by standard technique.

Heart rate :

Electrocardiograph of each volunteer was recorded from which the heart rate was calculated by dividing 1500 with R.R. interval.

Respiratory rate :

The number of chest movements in one minute were recorded which denoted the respiratory rate.

Maximum breath holding time :

The volunteers were instructed to holdthe breath at the end of deep inspiration and then with the help of stop watch the maximum duration for which they could hold the breath was recorded in seconds.

40 m.m. test :

For this test only the manometer part of the B.P. instrument was utilised. The volunteers took deep inspiration and then blew into the manometer tubing so as to raise the mercury column up to 40 m.m. of mercury. The duration for which he sustained the mercury column at 40 m.m. level was recorded with the help of stop watch. During this test care was taken so that the subject did not respire though the nasal passage.

Oxygen consumption :

To measure this parameter the volunteers were asked to take light meal at the previous evening and a sedative was given at night so that they had a sound sleep for 12-14 hours. Before measuring this parameter the volunteers were explained every thing so as to relieve them of anxiety and apprehension.

To measure oxygen consumption, the oxygen cylinder was connected to the Toshniwal expirograph and the instrument was rinsed with oxygen 3 to 4 times and finally the bell of the instrument was filled with sufficient oxygen so as to run the test for required time. Soda lime was kept in container inside the bell so as to absorb the carbon-di-oxide from the expired air. The volunteers was instructed to respire through Toshniwal expirograph with nose clampod. The student breathed normally for 7 minutes and during this period graphic recording were taken at the speed of 60 m.m./ minutes. The oxygen consumption was calculated from the obtained graphic recordings in litre per minute.

Basal Metabolic Rate :

The basal metabolic rate was calculated with the help of body surface area and corrected oxygen consumption which gave the value of energy production. Finally with the help of energy production, age and sex, the B.M.R. was calculated (Hock, 1976).

Lung Volume and Capacities :

The volunteer was connected with Toshniwal expirograph and all the lung volumes and capacities viz. Tidal volume, Inspiratory reserve volume, Inspiratory capacity, Expiratory reserve volume, Expiratory capacity maximum breathing capacity and Vital capacity were measured by using the speed of 60 m.m. per second and F E V_1 (Forced expiratory volume in first second) was calculated by using the speed of 1200 m.m. per second (Compbell and Dickinson, 1975).

HAEMATOLOGICAL PARAMETERS :

The blood samples were taken from the cubital vein of volunteers. For counting Differential Leucocyte, Total Leucocyte, Total Red Blood Cell, Platelets and for estimation of Erythrocyte Sedimentation Rate, Packed Cell Volume and Hb% the double exalated vials were used while for estimation of Blood Sugar Floride vial for Blood Urea single exalated vial and for Serum Cholesterol plain vial were used.

The total leucocyte count and total red cell count was done with Neubauer chamber. The Platelets count was done by using formal citrate as anticongulant by Neubauer chamber. Differential Leucocyte Count was done by staining the slide with Leishman stain. The haemoglobin was estimated by Sahlis haemoglobinometer. The erythrocyte sedimentation rate and packed cell

volume were measured with the help of Wintrobes tube as method described in Decie's practical haematology (1975).

BIOCHEMICAL PARAMETERS :

Blood Sugar :

Blood sugar was estimated by the method of Asatoor and King (modification of Folin-wu method) as described in Varley Practical Clinical Biochemistry, (1975).

Blood Urea :

Blood urea was estimated by Urease nesslerizations method as described in Varley Practical Clinical Biochemistry (1975).

Serum Cholesterol :

Serum cholesterol was estimated by ferric chloride method, Zlatkis, Zak and Boyle (1953).

OBSERVATIONS

O B S E R V A T I O N S

The present study was carried out on 28 cases, out of which 17 were male and 11 were female. The age of male cases ranged from 19 to 23 years and in female cases ranged between 18 - 22 years.

EFFECTS OF YOGIC PRACTICES ON CARDIOVASCULAR SYSTEM :

The effects of yogic exercises on cardiovascular system are summarised in table No.1 and Fig. No. 1. The mean systolic and diastolic blood pressure of the volunteers before starting yogic practice were 121.1±4.04 and 87.7±3.99 mm Hg respectively. Yogic practices produced a gradual lowering of both systolic and diastolic blood pressure. The fall in systolic blood pressure after 1 month, 2 months and 3 months of yogic practices were statistically significant. Although decrease in diastolic blood pressure was consistent but is only significant after 3 months.

In addition yogic practices produced a time dependent negative chronotrophic effects on heart. The heart rate was decreased for a mean control figure of 83.03±1.98 per minute to 76.82±1.57 after 1 month, 76.35±1.55 after 2 months and 71.85±1.08 after 3 months of yogic practices as shown in table No. 1, Fig. No. 1. Although the decrease in heart rate was small but statistically significant.

Table - 1

EFFECTS OF YOGIC PRACTICE ON CARDIOVASCULAR SYSTEM

GROUPS	BLOOD PRESSURE (mm Hg) SYSTOLIC (MEAN±S.E.)	BLOOD PRESSURE (mm Hg) DIASTOLIC (MEAN±S.E.)	HEART RATE PER MINUTE (MEAN±S.E.)
Control	121.1±4.04	87.7±3.89	83.03±1.98
1 month yoga practice	117.21±4.22***	77.6±1.17	76.82±1.57**
2 months yoga practice	115±1.47***	77.07±0.05	76.35±1.55***
3 months yoga practice	110.42±.92***	69.71±0.75***	71.85±1.08***

* Indicating P < 0.05

** Indicating P < 0.01

*** Indicating P < 0.001

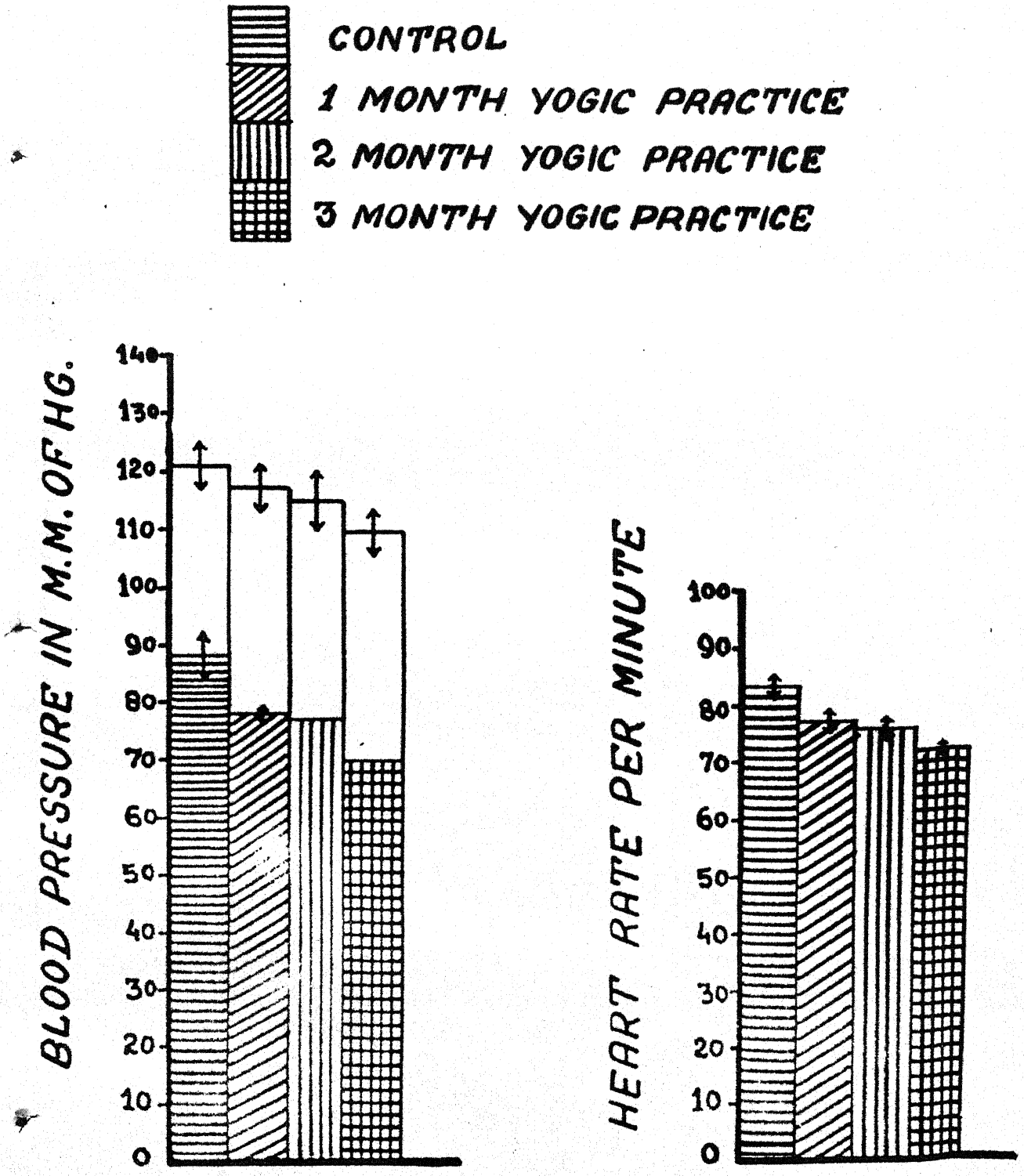


FIG. 1. SHOWS THE EFFECTS OF YOGIC PRACTIC
ON BLOOD PRESSURE AND HEART RATE

Table - 2 A

EFFECTS OF YOGIC PRACTICES ON RESPIRATORY FUNCTIONS

GROUPS	RESPIRATORY RATE PER MINUTE (MEAN±S.E.)	CHEST EXPANSION IN Cms. (MEAN±S.E.)	BREATH HOLDING TIME IN Sec. (MEAN±S.E.)	40 m.m. TEST IN Sec. (MEAN±S.E.)
Control	22.28±0.89	4.6±0.32	43.07±3.16	33.21±1.55
1 month yoga practice	19.25±0.71***	5.77±0.47***	57.39±4.32***	42.07±2.08***
2 months yoga practice	18.32±0.51***	7.25±0.49***	63.25±4.22***	46.75±2.01***
3 months yoga practice	16.21±0.40***	8.37±0.50***	67.42±5.85***	52.67±2.09***

*** Indicating P $\angle$ 0.001

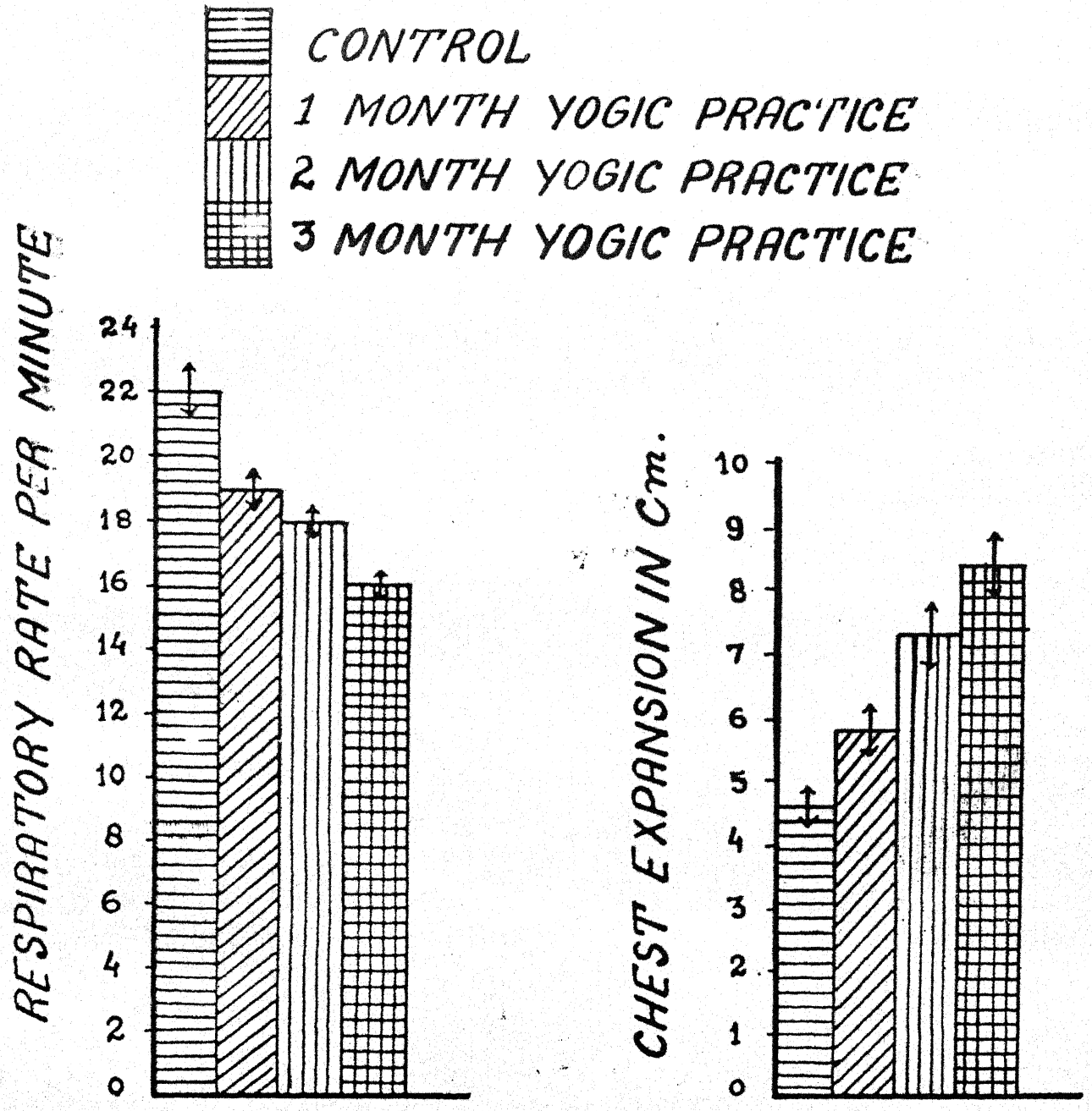


FIG. 2. SHOWS THE EFFECTS OF YOGIC PRACTICE ON RESPIRATORY RATE AND CHEST EXPANSION.

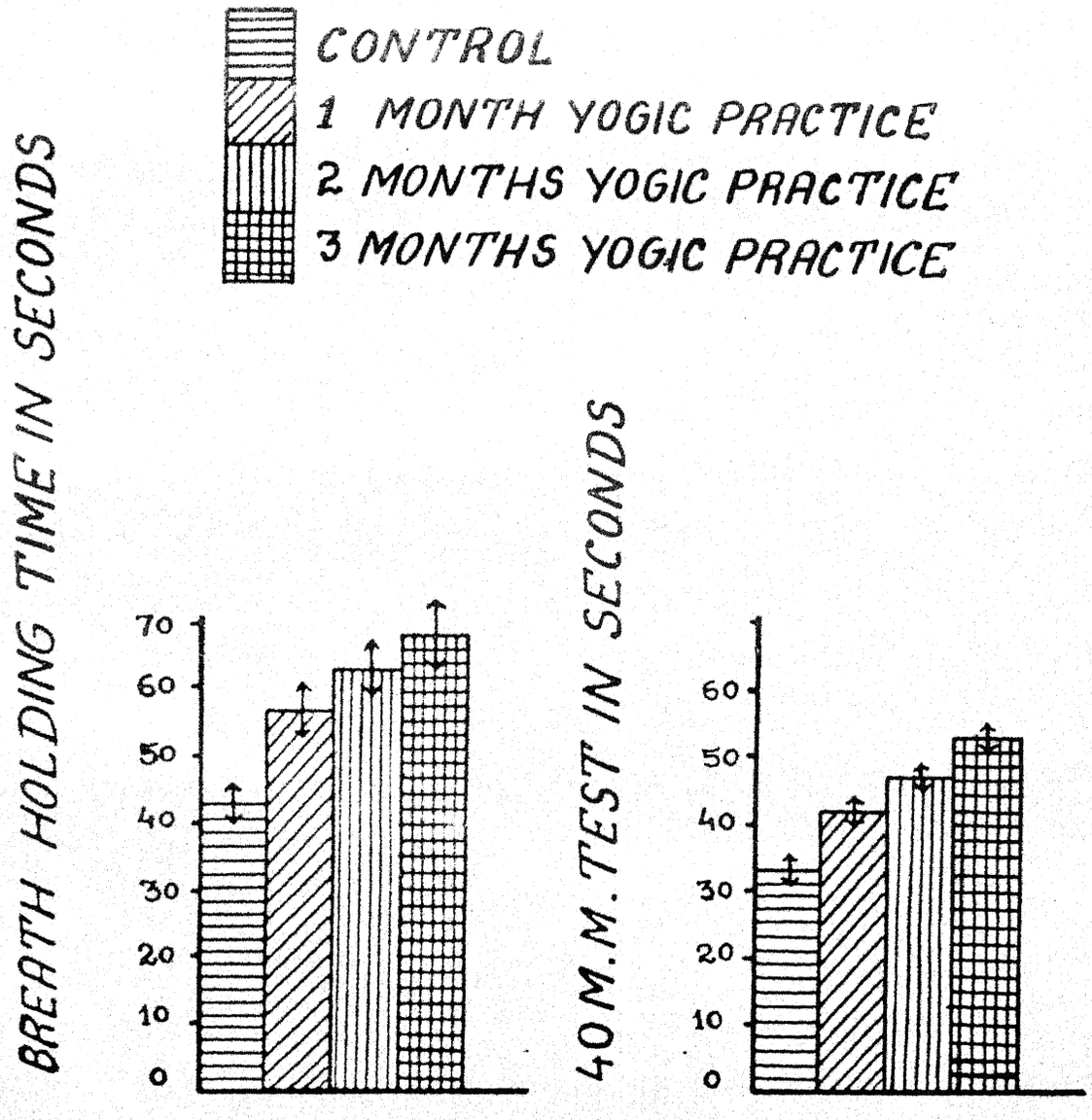


FIG.3. SHOWS THE EFFECTS OF YOGIC PRACTICE ON BREATH HOLDING TIME AND 40M.M.TEST.

EFFECTS OF YOGIC PRACTICES ON RESPIRATORY FUNCTIONS :

The effects of yogic practices on respiratory rate, chest expansion, breath holding time and 40 mm test are summarised in table No. 2 A and Fig. No. 2 and 3.

The respiratory rate was decreased for a mean control figure of 22.28±0.89 per minute to 19.25±0.71 after 1 momth, 18.32±0.51 after 2 months and 16.21±0.4 after 3 months of yogic practices as shown in table No. 1 A and Fig. No. 2. The decrease in respiratory rate after 1 month, 2 months and 3 months of yogic practices was statistically significant.

The effect of yogic practices on chest expansion showed an increase for a mean control group figure of 4.6±0.32 cms to 5.77±0.47 after one month, 7.25±0.49 after 2 months and 8.37±0.5 after 3 months as shown in table No. 2 A and Fig. No. 2. Yogic practices produced a gradual increase of chest expansion after 1 month, 2 months and 3 months which were statistically significant.

The breath holding time increased from a mean control figure 43.07±3.16 seconds to 57.39±4.32 after 1 month, 63.25±4.22 after 2 months and 67.42±5.85 after 3 months of yogic exercise as shown in table No. 2 A and Fig. No. 3. It shows gradual increase after 1 month, 2 months and 3 months. The increase in breath holding

Table - 2 B

EFFECTS OF YOGIC PRACTICES ON RESPIRATORY FUNCTIONS

GROUPS	TIDAL VOLUME IN Ml. (MEAN±S.E.)	INSPIRATORY RESERVE VOLUME IN Ml. (MEAN±S.E.)	INSPIRATORY CAPACITY IN Ml. (MEAN±S.E.)	EXPIRATORY RESERVE VOLUME IN Ml. (MEAN±S.E.)	EXPIRATORY CAPACITY IN Ml. (MEAN±S.E.)
Control	603 ± 35	1395±161	2032±87	805±76	1404±80
1 month yoga practice	509 ± 26**	1666±71**	2202±60	827±67	1461±11
2 months yoga practice	566 ± 36***	1744±81***	2273±106**	900±63	1561±85*
3 months yoga practice	668 ± 42***	1906±87***	2536±115***	1040±71**	1683±119***

* Indicating P ∠ 0.05

** Indicating P ∠ 0.01

*** Indicating P ∠ 0.001

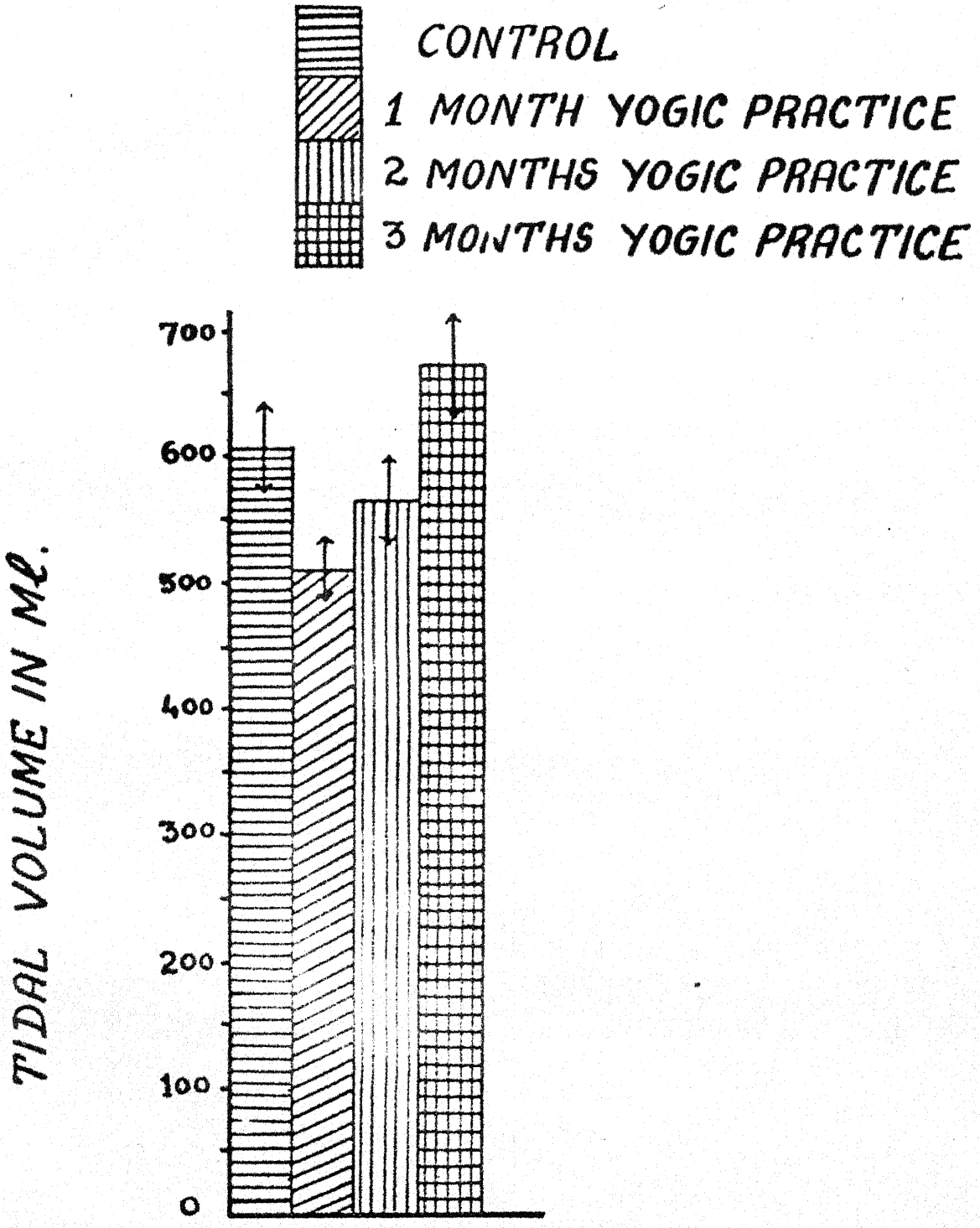


FIG. 4. SHOWS EFFECTS OF YOGIC PRACTICE ON TIDAL VOLUME.

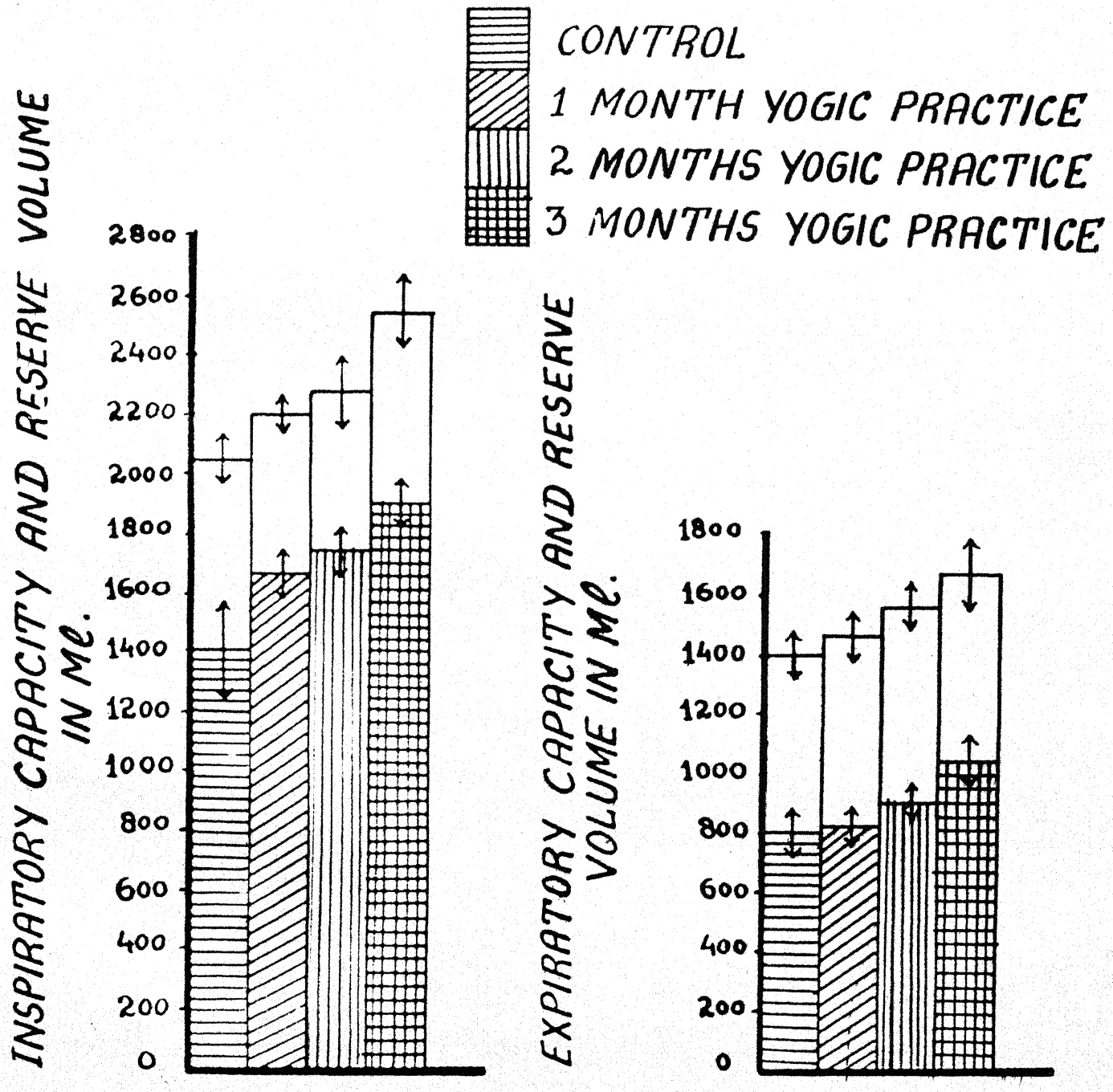


FIG.5. SHOWS EFFECTS OF YOGIC PRACTICES ON INSPIRATORY AND EXPIRATORY RESERVE

time after 1 month, 2 months and 3 months of yogic exercises were statistically significant.

The 40 mm test also showed gradual increase for a mean control figure of 33.21±1.55 seconds to 42.07±2.08 after 1 month, 46.75±2.01, after 2 months and 52.67±2.09 after 3 months of yogic practices as shown in table No. 2 A and Fig. No. 3 and statistically significant.

The effects of yogic practices on tidal volume are summarised in table No. 2 B and Fig. No. 4. It shows decrease after 1 month of yogic exercise for mean control figure 603±35 ml to 509±26 and after 2 months, 566±36 although after 3 months the tidal volume increased from mean control figure to 668±42 ml and statistically significant.

The inspiratory reserve volume showed gradual increase for mean control figure 1395±161 ml to 1666±71 after 1 month, 1744±81 after 2 months and 1906±87 after 3 months of yogic practices as summarised in table No. 2 B and Fig. No. 5. Statistically significant in 1 month and highly significant after 2 months and 3 months of yogic practices.

The inspiratory capacity also showed gradual increase for mean control figure 2032±87 ml to 2202±60 after 1 month, 2273±106 after 2 months and 2536±115 after 3 months of yogic practices as summarised in table No. 2 B and Fig. No. 5 but statistically

Table - 2 C

EFFECTS OF YOGIC PRACTICE ON RESPIRATORY FUNCTIONS

GROUPS	VITAL CAPACITY IN Ml. (MEAN ± S.E.)	F E V_1 (MEAN ± S.E.)	MAXIMUM BREATHING CAPACITY IN Lt. PER MINUTE (MEAN ± S.E.)
Control	2754 ± 118	63.18 ± 2.33	52.89 ± 2.74
1 month yoga practice	2944 ± 123***	80.22 ± 1.94***	64.03 ± 2.62***
2 months yoga practice	3002 ± 113***	87.21 ± 1.41***	74.39 ± 2.45***
3 months yoga practice	3276 ± 131***	92.79 ± 1.28***	87.08 ± 2.97***

* Indicating P ∠ 0.05

** Indicating P ∠ 0.01

*** Indicating P ∠ 0.001

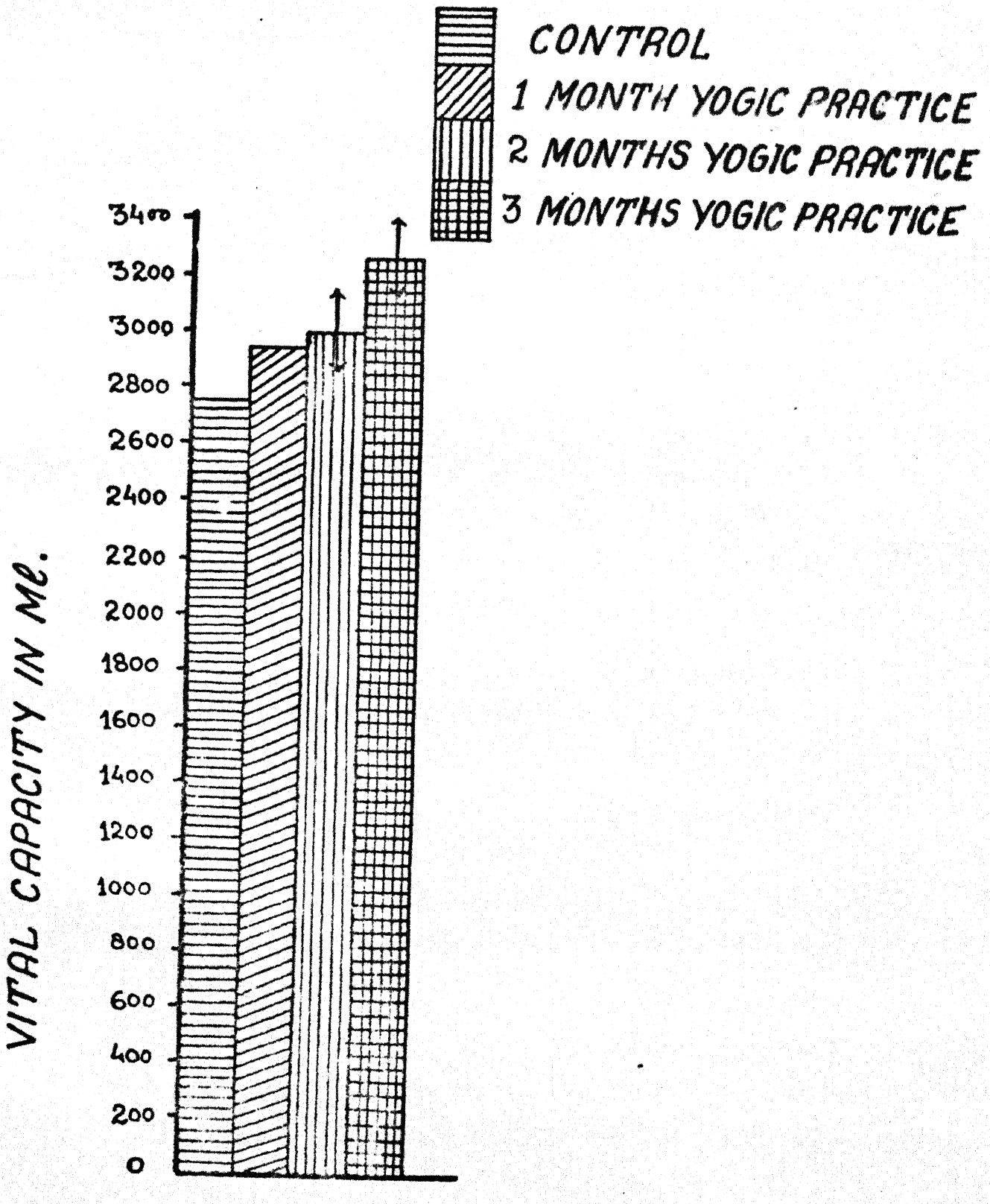


FIG. 6. SHOWS EFFECTS OF YOGIC PRACTICE ON VITAL CAPACITY.

significant after 2 and 3 months of yogic practices.

The expiratory reserve volume also showed a gradual increase for a mean control figure of 805±76 ml to 827±67, after 1 month, 900±63 after 2 months and 1040±71 after 3 months of yogic practices as summarised in table No. 2 B and Fig. No. 5 statistically significant only after 3 months of yogic exercise.

The effects of yogic exercises on expiratory capacity showed gradual increase for a mean control figure 1404±80 ml to 1461±11, after 1 month, 1561±85 after 2 months and 1683±119 after 3 months of yogic exercise as summarised in table No. 2 B and Fig. No. 5 but statistically significant after 2 and 3 months of yogic practices.

The vital capacity showed gradual increase for mean control figure 2754±118 ml to 2944±123 after 1 month yogic exercise, 3002±113 after 2 months of yogic exercise and 3276±131 after 3 months of yogic exercise as summarised in table No. 2 C and Fig. No. 6 and statistically significant after 1 month, 2 months and 3 months of yogic exercises.

The effects of yogic exercises on F E V_1 also showed a gradual increase for a mean control figure of 63.18±2.33 percent to 80.22±1.94 after 1 month, 87.21±1.41 after 2 months 92.79±1.28 after 3 months of yogic exercises as summarised in table No. 2 C and Fig.

Table - 3 A

EFFECTS OF YOGIC PRACTICE ON HAEMOPOIETIC FUNCTIONS

GROUPS	ERYTHROCYTE SEDIMENTATION RATE IN mm IN FIRST HOUR (MEAN±S.E.)	PACKED CELL VOLUME IN % (MEAN±S.E.)	HAEMOGLOBIN IN gm% (MEAN±S.E.)	RED BLOOD CELL COUNT IN MILLIONS PER Cu.mm. OF BLOOD (MEAN±S.E.)	PLATELET COUNT IN LACS PER Cu.mm.OF BLOOD (MEAN±S.E.)
Control	13.64±1.54	45.25±1.6	12.71±0.46	4.56±0.07	2.55±0.05
1 month yoga practice	11.14±1.69	46.64±1.08	12.9±0.4	4.84±0.16***	2.61±0.12**
2 months yoga practice	9.39±1.2*	46.39±1.70	13.96±0.09	4.84±0.15***	2.82±0.07***
3 months yoga practice	8.82±0.97**	45.92±0.29	14.36±0.22**	5.03±0.03***	2.97±0.01***

* Indicating P ∠ 0.05

** Indicating P ∠ 0.01

*** Indicating P ∠ 0.001

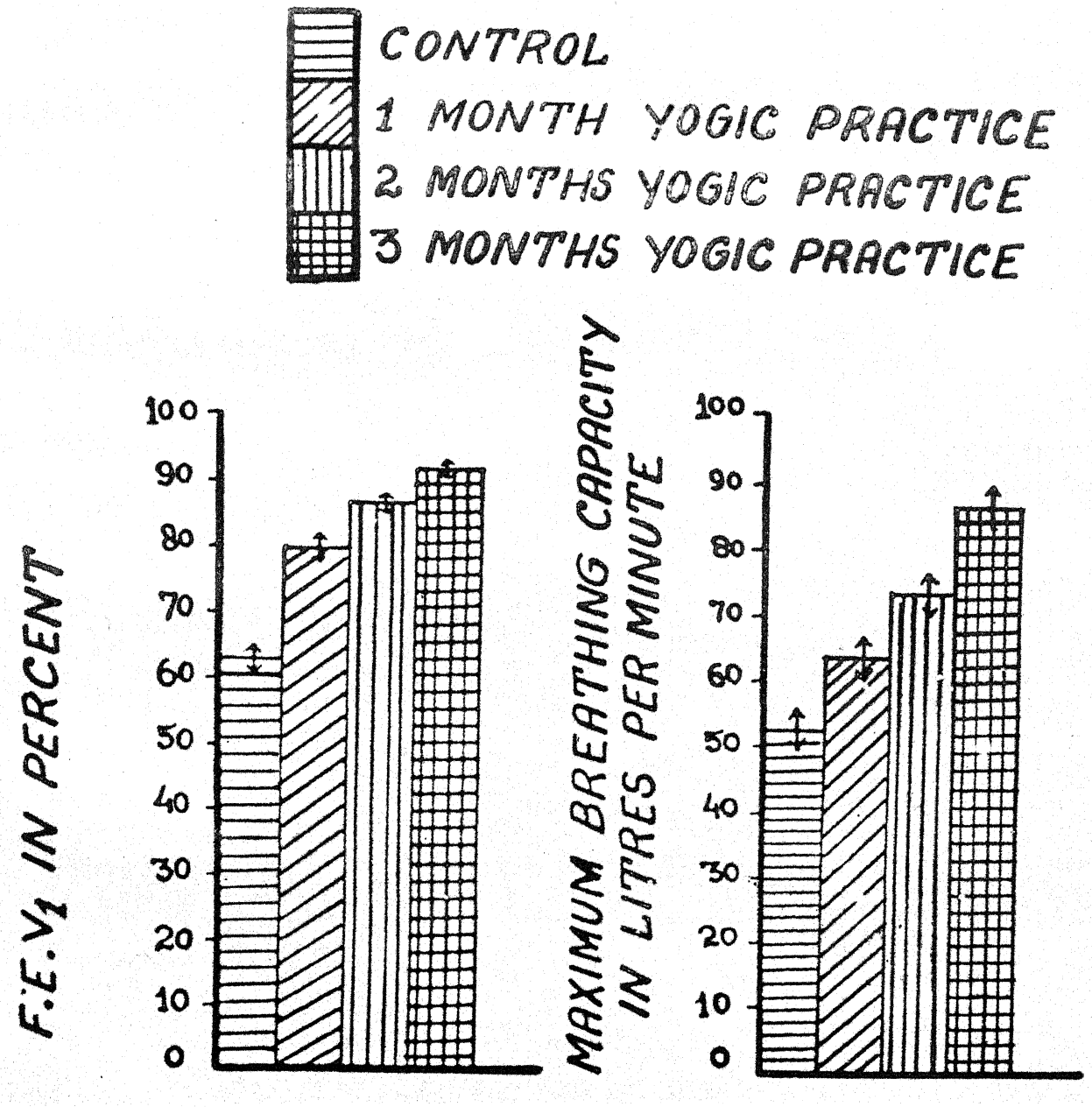


FIG.7. SHOWS EFFECTS OF YOGIC PRACTICE ON F.E.V_1 AND MAXIMUM BREATHING CAPACITY.

No. 7 and statistically significant after 1 month, 2 months and 3 months of yogic practices.

The maximum breathing capacity showed gradual increase from a mean control figure 52.89±2.74 lit. to 64.03±2.62 after one month, 74.39±2.45 after 2 months and 87.08±2.97 after 3 months of yogic practices as summarised in table No. 2 C and Fig. No. 7 and statistically significant after 1 month, 2 months and 3 months of yogic practices.

EFFECTS OF YOGA PRACTICE ON HAEMOPOIETIC FUNCTIONS :

The effect of yogic exercise is summarised in table No. 3 A and 3 B. The Erythrocyte Sedimentation Rate showed gradual decrease from a mean control figure 13.64±1.54 mm in first hour to 11.14±1.69 after 1 month, 9.39±1.2 after 2 months and 8.82±0.97 after 3 months of yogic practices as summarised in table No. 3 A and Fig. No. 8 and statistically significant after 2 months and 3 months of yogic exercises.

The packed cell volume showed no significant changes from mean control figure 45.25±1.6 percent to 45.92±0.29 after 3 months of yogic exercises as summarised in table No. 3 A.

The effects of yogic exercises showed gradual increase in haemoglobin gm.% from mean control figure 12.71±0.46 to 12.9±0.4 after 1 month, 13.96±0.09 after 2 months and 14.36±0.22 after 3 months of yogic

Table - 3 B

EFFECTS OF YOGIC PRACTICE ON HAEMOPOIETIC FUNCTIONS

GROUPS	TOTAL LEUCOCYTE COUNT PER CU.MM. OF BLOOD (MEAN ± S.E.)	DIFFERENTIAL LEUCOCYTE COUNT IN PERCENT				
		POLYMORPH (MEAN±S.E.)	LYMPHOCYTE (MEAN±S.E.)	EOSINOPHIL MEAN±S.E.)	MONOCYTE (MEAN±SE)	BASOPHIL MEAN±S.E.)
Control	6089±440	59.57±1.28	34.89±1.44	4.32±0.71	1.10±0.2	0
1 month yoga practice	7411±280***	59.28±.85	32.53±2.6	4±0.34	1.25±0.19	0
2 months yoga practice	7550±140***	59.46±0.64	35.1±1.03	3.85±0.32	1.57±0.21	0
3 months yoga practice	7840+360***	55.35+1.65*	38.5+0.09*	4.39+0.3	1.78+0.23	0

* Indicating P ∠ 0.05

** Indicating P ∠ 0.01

*** Indicating P ∠ 0.001

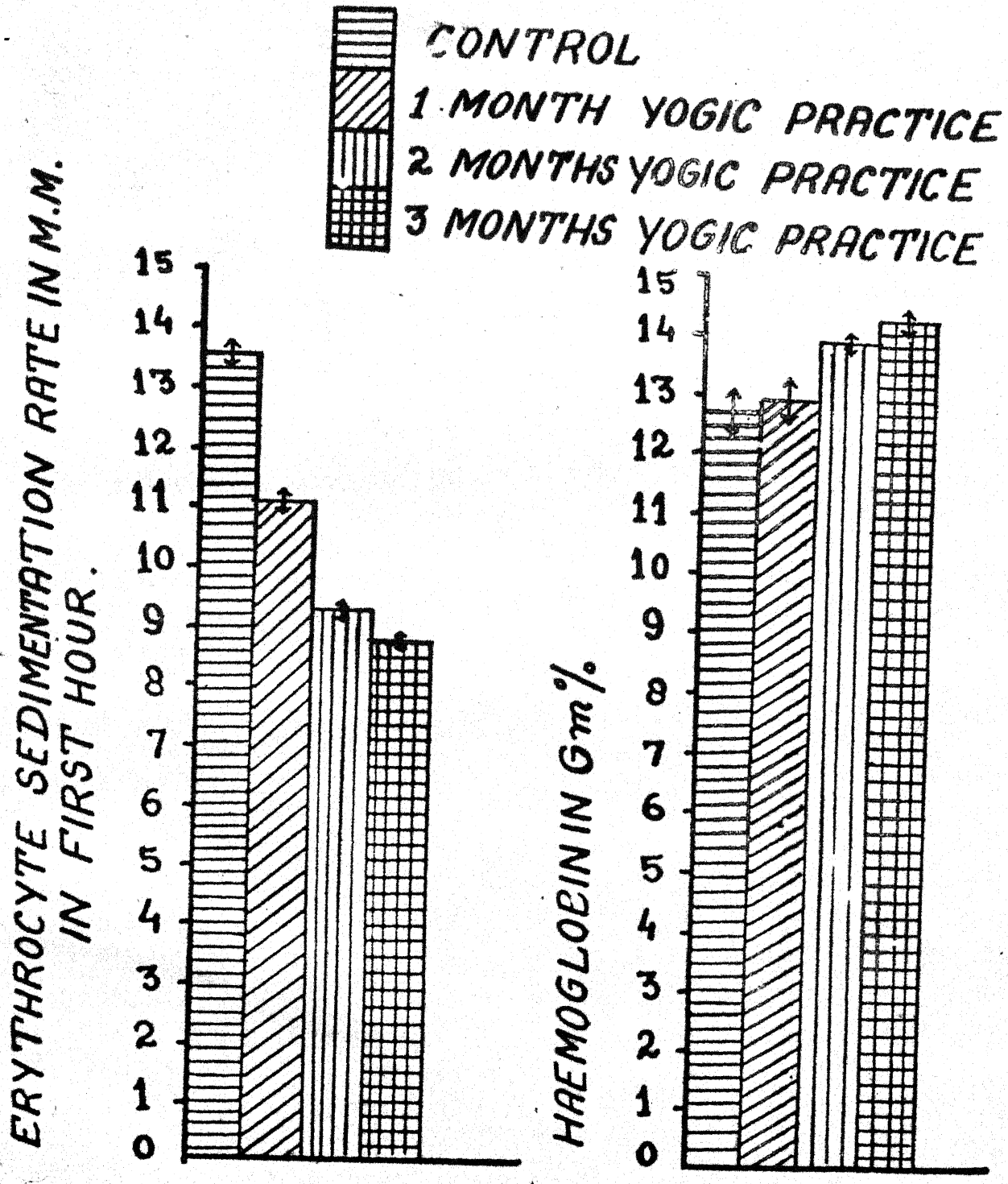


FIG. 8. SHOWS EFFECTS OF YOGIC PRACTICE ON E.S.R. AND HAEMOGLOBIN Gm.%.

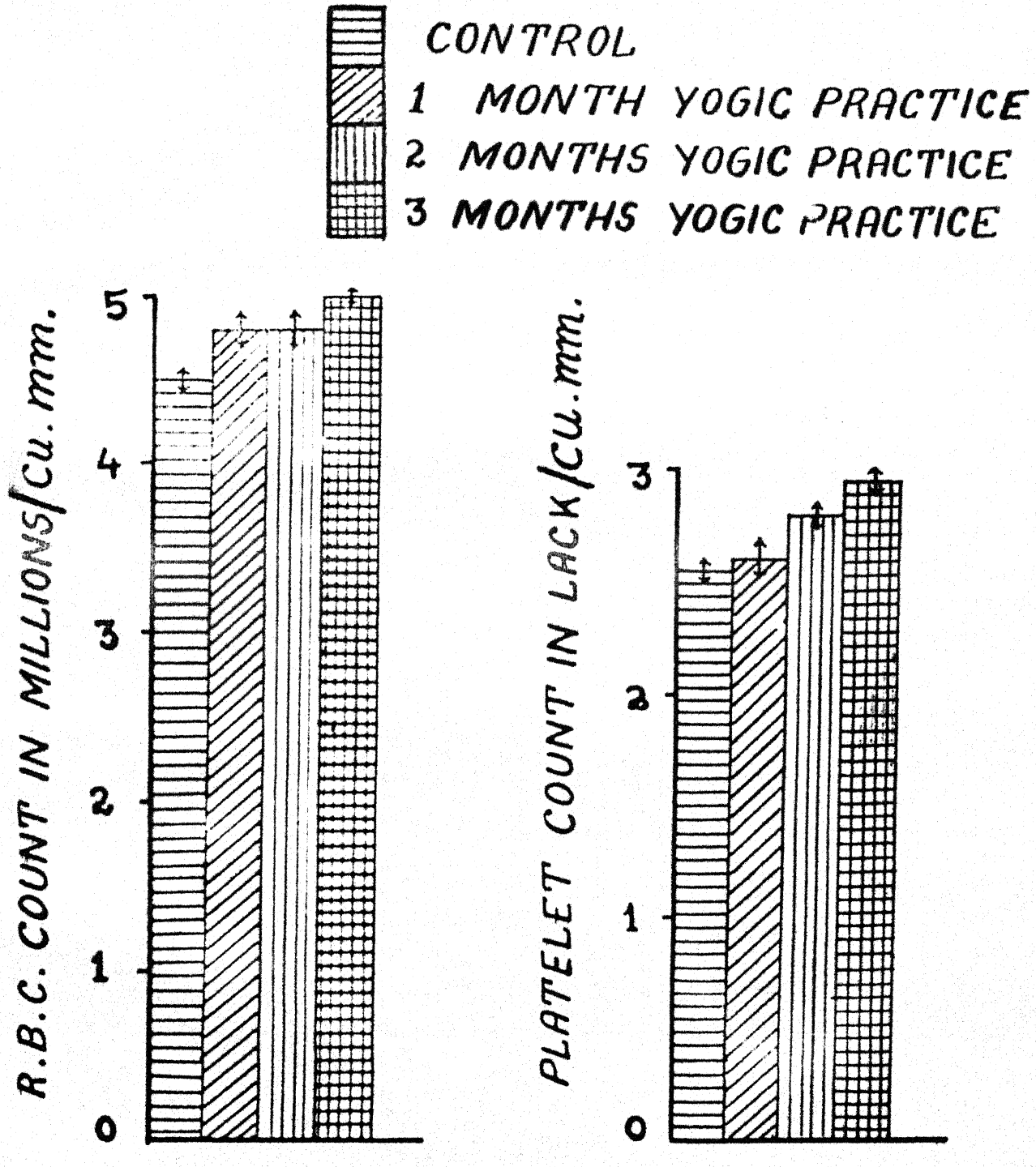


FIG. 9. SHOWS THE EFFECTS OF YOGIC PRACTICE ON R.B.C. COUNT AND PLATELET COUNT.

exercises as shown in table No. 3A and Fig. No. 8 but the difference was statistically significant only after 3 months yogic exercises.

The red blood cell count showed gradual increase from a mean control figure 4.56±0.07 millions per cu.mm. of blood to 4.84±0.16 after 1 month, 4.84±0.15 after 2 months and 5.03±0.03 after 3 months of yogic exercises as summarised in table No. 3 A and Fig. No. 9 and statistically significant after 1 month, 2 months and 3 months of yogic exercise.

The platelets count also showed gradual increase from a mean control figure 2.55±0.05 lacs/cu.mm of blood to 2.61±0.12 after 1 month, 2.82±0.07 after 2 months and 2.97±0.01 after 3 months of yogic practices as summarised in table No. 3 A and Fig. No. 9 and statistically significant after first, 2nd and 3rd months of yogic exercises.

Total leucocyte count showed gradual increase from a mean control figure 6089±440 thousands per cu.mm of blood to 7411±280 after 1 month, 7550±140 after 2 months and 7840±360 after 3 months of yogic practices as summarised in table No. 3 B and statistically significant after 1 month, 2 months and 3 months of yogic exercises.

The differential leucocyte count did not show any remarkable changes. Only lymphocyte count increased from a mean control figure 34.89±1.44 percent to 38.5±0.09 after 3 months of yogic exercises as summarised

in table No. 3 B and statistically significant only after 3 months of yogic practices.

EFFECTS OF YOGIC PRACTICE ON BODY WEIGHT, BASAL METABOLIC RATE AND OXYGEN CONSUMPTION :

The effects of yogic practices on body weight showed slight increase from a mean control figure 52.28±1.52 kgs to 52.58±2.1 after 1 month, 53.44±1.82 after 2 months and 53.63±1.19 after 3 months of yogic exercises and statistically significant after 2 and 3 months of yogic exercises as summarised in table No. 4.

The Basal Metabolic Rate showed gradual reduction from a mean control figure 28.44±2.00 percent to 24.07±2.48 after 1 month, 5.75±2.79 after 2 months and 12.14±1.93 after 3 months of yogic exercises and statistically significant after 1 month, 2 months and 3 months of yogic practices as summarised in table No. 4 and Fig. No. 10.

The oxygen consumption also showed gradual decrease from mean control figure 311.78±13.30 ml to 292.5±14.69 after 1 month, 241.07±7.94 after 2 months and 196.07±4.99 after 3 months of yogic practices as summarised in table No. 4 and Fig. No. 10 and statistically significant after 1 month, 2 months and 3 months of yogic practices.

Table - 4

EFFECTS OF YOGIC PRACTICE ON BODY WEIGHT, BASAL METABOLIC RATE AND OXYGEN CONSUMPTION

GROUPS	BODY WEIGHT IN kgs. (MEAN ± S.E.)	BASAL METABOLIC RATE IN % (MEAN ± S.E.)	OXYGEN CONSUMPTION IN ML./MINUTE (MEAN ± S.E.)
Control	52.28 ± 1.52	28.44 ± 2.00	311.78 ± 13.30
1 month yoga practice	52.58 ± 2.1	24.07 ± 2.48***	292.5 ± 14.69***
2 months yoga practice	53.44 ± 1.82*	5.75 ± 2.79***	241.07 ± 7.94***
3 months yoga practice	53.63 ± 1.19**	-12.14 ± 1.93***	196.07 ± 4.99***

* Indicating P ≤ 0.05
** Indicating P ≤ 0.01
*** Indicating P ≤ 0.001

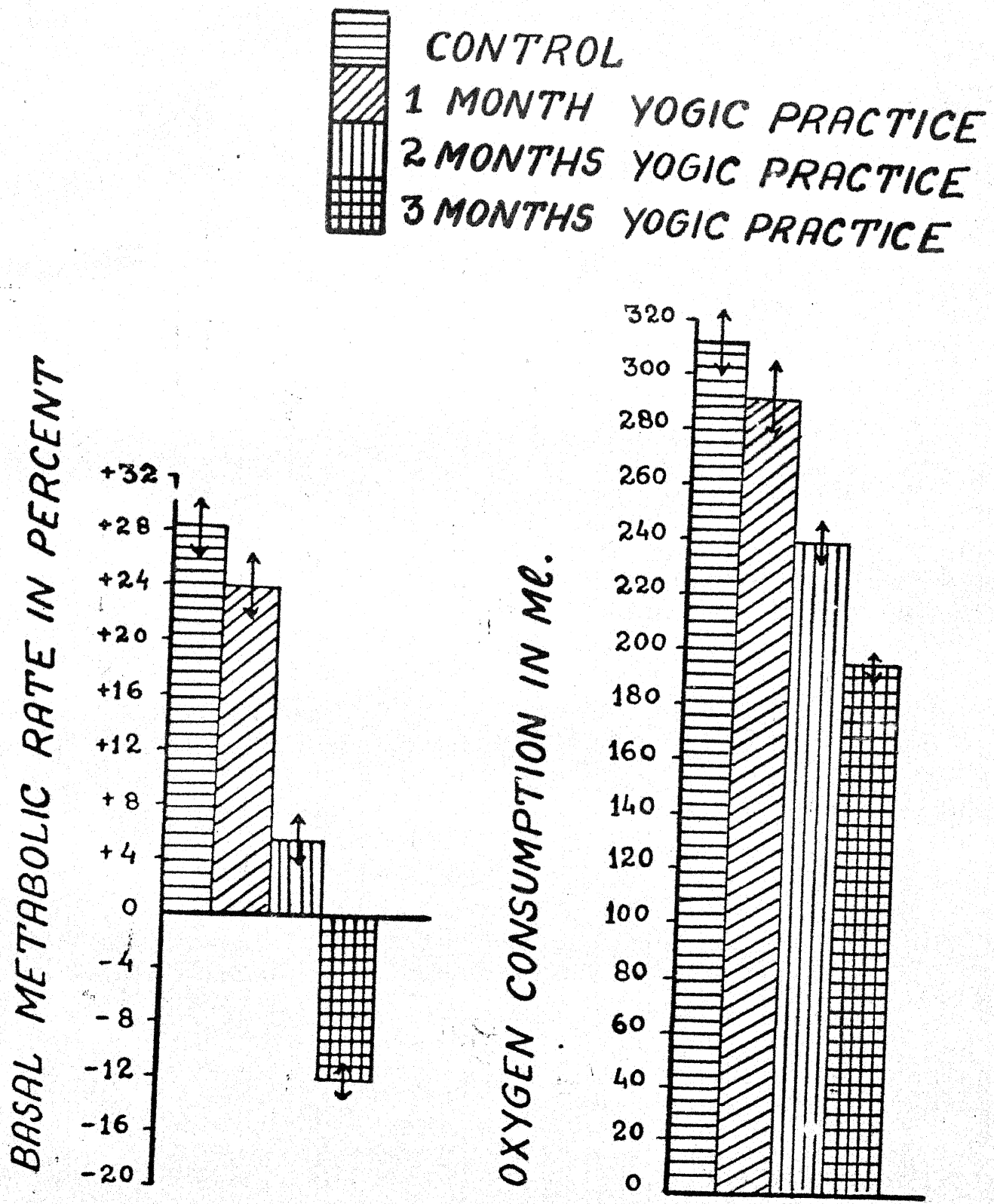


FIG. 10. SHOWS EFFECTS OF YOGIC PRACTICE ON BASAL METABOLIC RATE AND OXYGEN CONSUMPTION.

Table - 5

EFFECTS OF YOGIC PRACTICE ON METABOLIC FUNCTIONS

GROUPS	BLOOD SUGAR IN mg% (MEAN ± S.E.)	BLOOD UREA IN mg% (MEAN ± S.E.)	SERUM CHOLESTEROL IN mg% (MEAN ± S.E.)
Control	94.21 ± 2.47	24.07 ± 0.82	214.21 ± 4.39
1 month yoga practice	87.17 ± 1.03**	23.75 ± 0.76*	203 ± 5.66*
2 months yoga practice	83.03 ± 1.5***	22.6 ± 0.78**	196.35 ± 4.62***
3 months yoga practice	79.60 ± 1.36***	19.92 ± 0.76***	194.75 ± 4.13***

* Indicating P $\leq$ 0.05
** Indicating P $\leq$ 0.01
*** Indicating P $\leq$ 0.001

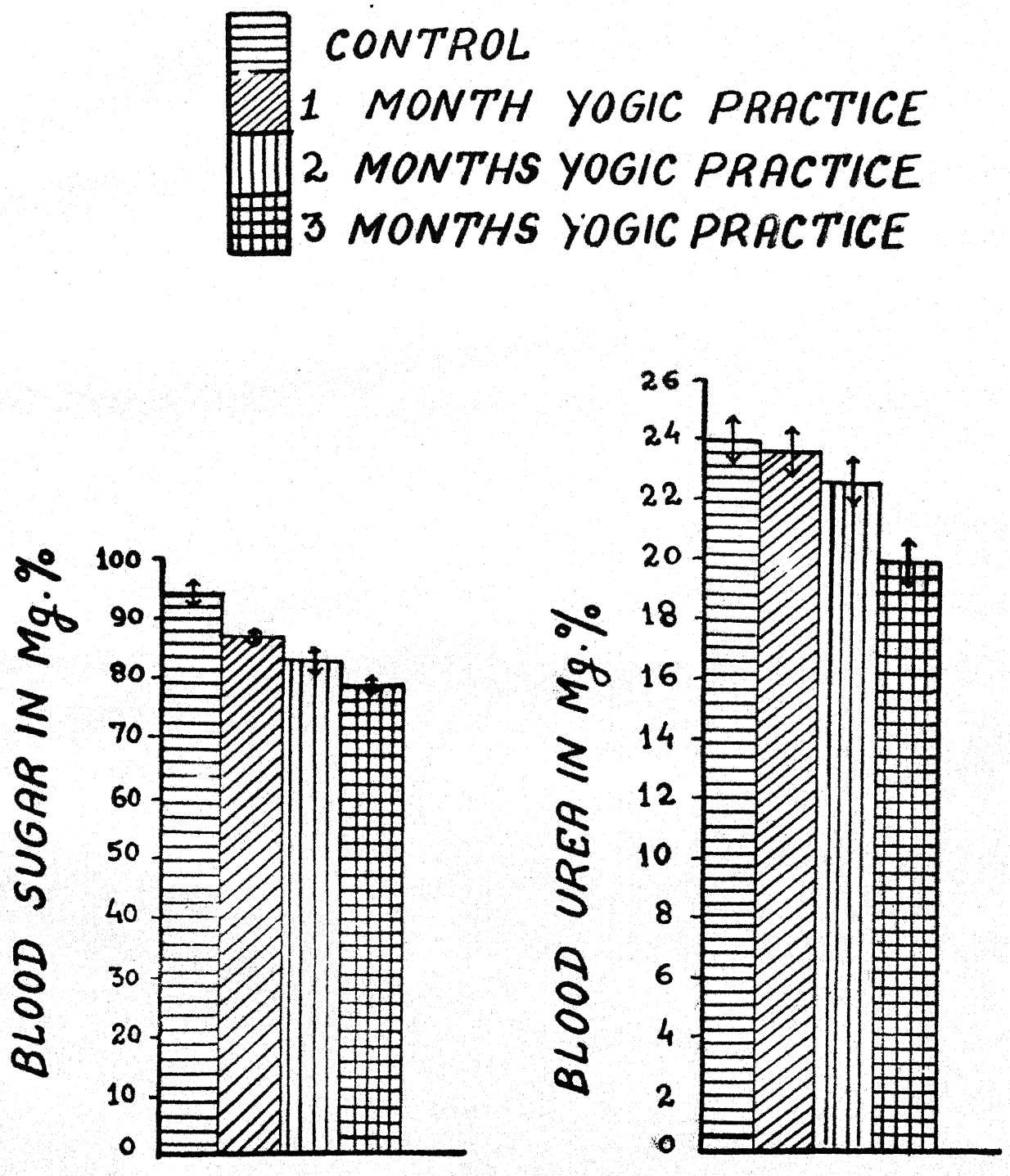


FIG. 11. SHOWS EFFECTS OF YOGIC PRACTICE ON BLOOD SUGAR AND BLOOD UREA.

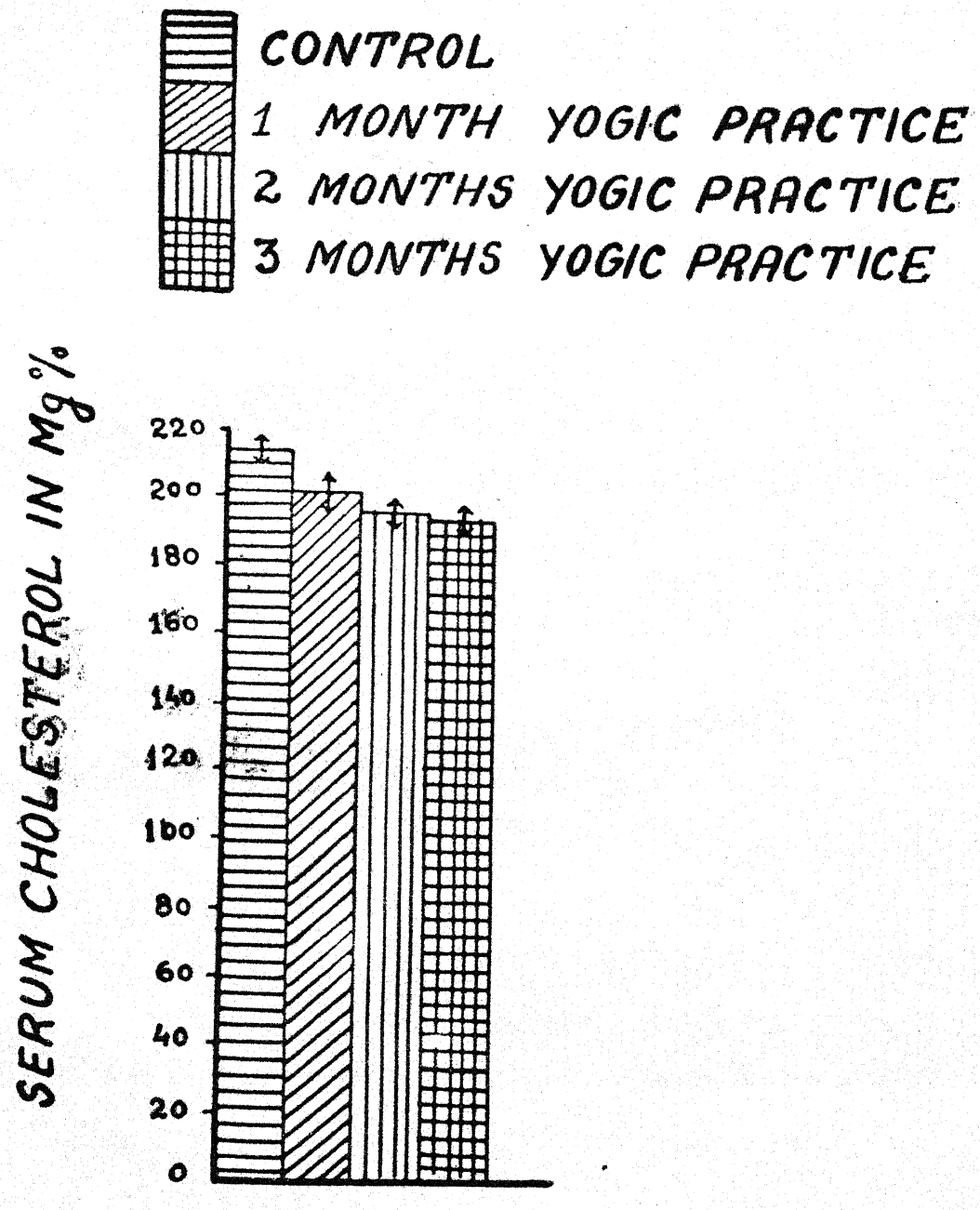


FIG.12. SHOWS EFFECTS OF YOGIC PRACTICE ON SERUM CHOLESTEROL.

EFFECTS OF YOGIC PRACTICE ON METABOLIC FUNCTION :

The effects of yogic exercises on metabolic function are summarised in table No. 5. The blood sugar showed gradual decrease from mean control figure 94.21±2.47 mg % to 87.17±1.03 after 1 month, 83.03±1.5 after 2 months and 79.6±1.36 after 3 months of yogic practices as summarised in table No. 5 and Fig. No. 11 and statistically significant after 1 month, 2 months, and 3 months of yogic practices.

The blood urea also showed gradual decrease from mean control figure 24.07±0.82 mg % to 23.75±0.76 after 1 month, 22.6±0.78 after 2 months and 19.92±0.76 after 3 months of yogic practices as summarised in table No. 5 and Fig. No. 11 and statistically significant after 1 month, 2 months and 3 months of yogic practices.

The effects of yogic practices on serum cholesterol showed gradual decrease from a mean control figure 214.21±4.39 mg% to 203±5.66 after 1 month, 196.35±4.62 after 2 months and 194.75±4.13 after 3 months of yogic practices as summarised in table No. 5 and Fig. No. 12 and statistically significant after 1 month, 2 months and 3 months of yogic exercises.

DISCUSSION

DISCUSSION

The practice of yoga in contrast to physical exercise exerts minimum physical efforts but influences vital organs and neuroendocrine system to induce the variety of physiological changes (Udupa et al, 1972, Singh et al, 1972, Udupa et al, 1973 and 1975). Yogic asanas are a preliminary stage in the comprehensive classical practice of yoga although each and every yogic asana produces specific physiological effect (Udupa et al, 1975) but combined practice of several important asanas have shown considerable improvement in cardio-respiratory, metabolic and adrenocortical functions (Udupa et al, 1972, 1973, 1974).

A number of reports are available in which wall trained yogis by vitrue of yogic practice can manipulate the function of vital organs of body, who resist death and attain samadhi being confined in a sealed box for number of days. An ordinary man usually can not survive in an environment where there has been no air or oxygen but yogis are known to survive in such conditions for number of days. During confinement even any electrical sign of cardiac activity is not seen but it returns to normal after they are released out of the confinement (Anand et al, 1961). These studies indicate that an individual can attain enormous power to control over his body functions by doing yogic practices.

Although a good number of studies have been conducted to show the physiological, biochemical and phychological, effects of yogic practices but most of the studies have not drawn any specific conclusion. Therefore the present work has been undertaken to study the physiological, biochemical and haematological effects produced by yogic practices which can be therapeutically exploited in future on the basis of physiological changes.

In present study a group of yogic exercises have been performed by 28 healthy volunteers and produced a highly significant fall in systolic blood pressure at the end of first month, second month and third month of yogic practices ($P<0.001$) but there was a significant fall in diastolic blood pressure only at the end of third month ($P<0.001$). The decrease in systolic and diastolic blood pressure due to yogic practices in this study is in agreement with earlier reports (Chhina et al, 1969; Udupa et al, 1971, 1972, 1975, Gopal et al, 1973, Kothari et al, 1973, Patel et al, 1975, Misra et al, 1977, Bhole et al, 1977, Naini et al, 1979, Lakshmikanthan et al, 1979 and Sachdeva et al, 1980).

Similarly there was a definitly significant decrease in heart rate at the end of first month ($P<0.01$), second month ($P<0.001$) and third month ($P<0.001$). This decrease in heart rate is in agreement

with earlier reports of Anand et al (1960, 1961), Wenger and Bagchi (1961), Rao et al (1963, 1968), Chhina et al (1968), Wallace et al (1970), Lal et al (1971), Mookherjee et al (1974), Lobo et al (1974), Udupa et al (1974), Bhatnagar et al (1974), Patel et al (1975), Nayer et al (1975), Misra et al (1977), Maini et al (1978) and Gore et al (1980).

Although a gradual decrease in blood pressure and heart rate is a consistent finding after varying period of yogic exercises but it is difficult to explain the mechanism how these effects are produced. Wenger and Bagchi (1961) investigated 4 yogis and concluded that yogic exercises could increase the vagal tone of unknown origin. Moreover, it has been recognised that cardiovascular responses both in normal and abnormal individuals can be influenced by definite envioronmental conditions and by a wide variety of behavioural factors such as stress, anxiety and numerous effective and altitudinal dispositions of the individual (Gutmenn and Benson, 1971). Thus chronic arousal of hypothalamic emergency reactions which are associated with increased sympathetic nervous system activity was believed to lead to elevated systemic arterial blood pressure (Cannon, 1929). If this is the true alteration in behaviour which were associated with decreased sympathetic activity, will lead to depression in blood pressure.

Yogic practices and transcendental meditation are known to cause behavioural alteration and reduce anxiety and tension, leading to diminished blood pressure (Wallace et al, 1971, Benson and Wallace, 1972). Thus it appears that the yogic practices reduce sympathetic tone and increase vagal tone probably to produce beneficial effect on cardiovascular system.

In the present study combined practice of yogic exercises have shown to produce a significant change in respiratory functions. With increase in yogic exercises a significant decrease in respiratory rate ($P<0.001$) and increase in chest expension ($P<0.001$), breath holding time ($P<0.001$), 40 mm test ($P<0.001$) F E V_1 ($P<0.001$) and maximum breathing capacity ($P<0.001$) at the end of first, second and third month. Unexpectedly there was a decrease in tidal volume at the end of first month and then it increased gradually afterwards finally leading to statistically significant increase at the end of third month ($P<0.001$).

There was a gradual increase in insipratory reserve volume at the end of first month ($P<0.01$), second month ($P<0.001$) and third month ($P<0.001$). There was no change in inspiratory capacity at the end of first month but it increased significantly at the end of second month ($P<0.01$) and third month ($P<0.001$).

The expiratory reserve volume increased significantly only at the end of third month ($P<0.01$) while expiratory capacity increased significantly at the end of second month ($P<0.01$) and third month ($P<0.001$). Significant increase in vital capacity was noted at the end of first month ($P<0.01$), second month ($P<0.001$) and third month ($P<0.001$). These observation are in accordance with earlier reports (Bhole et al, 1970, Udupa et al, 1971, 1972, 1974, 1975, Lal et al, 1971 Gopal et al, 1973, Bhatnagar et al, 1974, 1975, Nayer et al, 1975, Agarwal et al, 1977, Suresh et al, 1977 Maini et al, 1978, 1979). However, the respiratory rate decreased to a significant extent which is in consistent with other reports (Chhina et al, 1968, Rao et al, 1968, Datey et al, 1969, Wallace et al, 1970, Lal et al, 1971, Udupa et al, 1971, 1972, 1974, Gopal et al, 1973, Kothari et al, 1973, Mookherjee et al, 1974, Lobo et al, 1974, Bhatnagar et al, 1974 and Maini et al, 1979). The yogic exercises specially the breathing exercises by making full use of the diaphragm and abdominal muscles clears the respiratory passage and all alveoli making room for more air (Bhole et al, 1970). Moreover pranayamic exercises by increasing the elasticity of joints and muscles and by reducing the viscous resistance of lung (Suresh et al, 1977), there by the lung volumes and capacities are probably increased.

The yogic practices in present study have produced a gradual decrease in Erythrocyte Sedimentation Rate but it significantly decreased only at the end of second month ($P<0.05$) and third month ($P<0.01$), although the changes in packed cell volume were not statistically significant but a tendency of slight increase after yogic practices was observed. The red blood cell count increased significantly at the end of first, second and third month ($P<0.001$). Platelet count increased significantly at the end of first month ($P<0.01$), second month ($P<0.001$) and third month ($P<0.001$).

The haemoglobin level increased significantly only at the end of third month ($P<0.01$). The increase in haemoglobin in the study supports the finding of Maini et al, 1978. Since the rate of sedimentation of red cells is influenced by a number of interreacting factors, it is difficult to explain how yogic practices bring about lowering of Erythrocyte Sedimentation Rate. But ratio of red cells to plasma is one of the factors which effects Erythrocyte Sedimentation Rate. Decrease in red blood cell count and packed cell volume may possibly explain the lowering of Erythrocyte Sedimentation Rate after yogic practice (Dacies Practical Haematology, 1975). Yogic practises have not only increased red blood cell count but also increased other cellular compenents of blood like leucocytes and platelets.

There was an increase in total leucocyte count at the end of first, second and third month ($P<0.001$). There was not much change in differential leucocyte count except that a significant increase in lymphocyte count was seen at the end of third month ($P<0.05$). The increase in lymphocyte count observed in this study is in agreement with Misra et al, 1977 and Mookherjee et al, 1974. Physical exercises and stressful situations increase corticosteroids synthesis and raise plasma steroid level. Glucocorticoids influence the formed elements of the blood after glucocorticoid therapy. The haemeglobin, red blood cell count and polymorphoneuclear leucocytes are increased and lymphocytes and other leucocytes are decreased (Goodman, Gillman, 1980). Since yogic practices are one of the types of physical postures which might be associated with increased glucocorticoid level, but the increase in haemoglobin and red blood cell count supports increased steroidogenesis but low polymorph and high lymphocyte count are in contrast to the speculation. So it is difficult to draw a definite conclusion to explain the mechanism of changes in haemopoietic parameters.

In the present investigation, yogic practices appears to stimulate anabolism and decrease catabolism, evidenced by increased body weight which is statistically significant at the end of second month ($P<0.05$) and

third month ($P<0.01$). The decrease in basal metabolic rate was statistically significant at the end of first, second and third month ($P<0.001$) and decreased oxygen consumption at the end of first, second and third month ($P<0.001$). Sachdeva et al, 1980 reported decrease in basal oxygen consumption by 20-25%. They postulated that the decrease in peripheral resistence produced by yogic practices resulted in lowering of blood pressure and possibly increase muscular relaxation along with a decrease in sympathetic tone produced a decrease oxygen consumption in this study is in agreement with the observation of Anand and Chhina, 1960, 1961, 1968, Wenger and Bagchi, 1961, Rao, 1963, 1968, Datey, 1969 and Wallace, 1970, 1971, 1974. However, Miles, 1964, Rao, 1968 and Bhatnagar, 1974 have reported increased oxygen consumption in yogic practices. Increase in body weight might be primarily due to decreased metabolism probably due to relaxation by exercises of yogic practices. Effect of yoga on body weight is controversial. Some workers, Udupa et al, 1971, 1972, 1974, Kothari et al, 1973 and Bhatnagar et al, 1974 have showed decrease in body weight whereas other workers (Maini, 1978, Laxmikanthan, 1978 and 1979) have observed an increase in body weight after yogic practices. However, an increase in body weight has been observed in this study.

Udupa et al, 1972 have also noticed increased urinary excretion of testosteron. The increased excretion might be due to increased plasma testosteron level. Although it has not been estimated. The higher testosteron synthesis might be exerting anabolic effect and gain in body weight.

Yogic practices resulted in lowering of blood sugar at the end of first ($P<0.01$), second ($P<0.001$) and third month ($P<0.001$). Blood urea showed a gradual decrease which was statistically significant at the end of first month ($P<0.05$), second month ($P<0.01$) and third month ($P<0.001$) and serum cholesterol at the end of first month ($P<0.05$), second month ($P<0.001$) and third month ($P<0.001$). The decrease in blood sugar and serum cholesterol is in agreement with observation of Udupa et al, 1971, 1972, 1974, 1975, Gopal et al, 1973, Kothari et al, 1973, Mookherjee et al, 1974, Agarwal et al, 1977, Misra et al, 1977, Karambellakar, 1977, Srikrishana et al, 1980 and Rao, 1980. On endocrine and metabolic assessment Udupa et al (1972) noticed an enhanced adrenocortical activity as evidenced by increased 17-hydroxy corticosteroid excretion and reduction in serum cholesterol level. Thus decrease in serum cholesterol was probably due to increase synthesis of adrenocorticoids from body cholesterol.

Yogic exercises not only reduce the blood glucose level in normal healthy volunteers but these are known to reduce blood glucose in diabetic patients. In the present study it is not possible to explain the exact way how yogic exercises reduce the blood glucose level and benefit diabetic patients, because no attempt has been made in earlier studies as well as in the present study to reveal blood insulin level and other antagonistic hormones, which need further study.

The various findings which were observed after three months of yogic practice in this study are in agreement with the observations of other workers. However the mechanism of physiological changes which are induced by yogic training is not clear and a controversy regarding it still persists. Various authors have given various reasons but none of them are widely accepted. The most accepted view is that yoga effects the autonomic nervous system by decreasing sympathetic tone. The possible side of action may be hypothalamus which regulates the autonomic nervous system.

This study as well as studies by other worker clearly indicate that it needs a scientific approach and a long term plan to get all the roots of yoga to reveal the mystery.

CONCLUSION

CONCLUSION

The present study was carried out on 28 normal healthy young medical students of M.L.B. Medical College, Jhansi in order to see the effect of yogic exercises, on Cardio-respiratory system, Haemopoietic system and metabolic functions of the body. The age of volunteers ranged from 18-23 years. The yogic training was given for three months and the volunteers were subjected to practice 10 asanas, 5 mudras, 5 pranayams and 5 bandhas regularly for one and half hour daily in the evening.

Yogic practices are known to increase vagal tone and decrease sympathetic tone, thus they induce decrease in systolic and diastolic blood pressure and in heart rate as well. In confirmation with this explanation in the present study it was seen that there was a statistically significant fall in systolic blood pressure after first month, second month and third month but the fall in diastolic blood pressure was significant only after third month. Similarly there was statistically significant fall in heart rate after first, second and third months of yogic exercises.

There was a significant decrease in respiratory rate, increase in chest expansion, breath holding time,

40 m.m. test after first, second and third month of yogic practices. Although the tidal volume decreased after first month of yogic exercises but there was statistically significant rise in the tidal volume at the end of third month of yogic practices. There was an increase in inspiratory reserve volume, inspiratory capacity, expiratory reserve volume, expiratory capacity and vital capacity after first, second and third month of yogic exercises. Similarly F E V_1 and maximum breathing capacity showed a definite statistically significant increase after first, second and third month of yogic practices. Pranayamic exercises are known to reduce the viscous resistances of lungs thereby increasing the volume and capacities of lungs.

On observing the effects of yoga practice on haemopietic system, it was seen that there was a decrease in erythrocyte sedimentation rate, increase in haemoglobin gm. percent, total red blood cell count and platelets count. There was no significant change in packed cell volume. The total leucocyte count increased and this increase was statistically significant after first, second and third month of yogic exercises. It has been seen that all the formed elements of blood increase after yogic practices. It may be argued that yoga so-me how stimulates the bone

marrow resulting in an increase in all the cellular components of blood. There was no definite change in differential leucocyte count except that there was an increase in lymphocyte count at the end of third month of yogic exercises.

In present study there was statistically significant increase of weight at the end of second and third months. Higher concentrations of testosteron have been reported in persons practising yogic exercises and probably this increase testosteron caused increased anabolism resulting increase in weight. There was a statistically significant decrease in basal metabolic rate and oxygen consumption when recorded for similar periods. This decrease in basal oxygen consumption is postulated to be because of decrease in peripheral resistance produced by yogic practices, resulted in lowering of blood pressure and possibly increase muscular relaxation along with a decrease in sympathetic tone produced a decreased oxygen demand in basal conditions.

On observing the effects of yogic exercises on metabolic functions, a consistent and definite fall in blood urea, blood sugar and serum cholesterol was found in first, second and third months yogic exercises. It has been postulated that increased conversion of cholesterol to corticosteroids results in decreased cholesterol probably.

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APPENDICES

PROFORMA

Name : Address :

Age :

Sex :

Height Cms. Weight kgs. Surface area Square Cms.

P/H

PRESENT HEALTH

DIET

HISTORY OF EXERCISE IN PAST

TEMPERATURE

MENSTRUAL HISTORY SOCIAL STATUS BATH HOT COLD

EXAMINATION :- Bar. Pressure Room Temperature

C.N.S.

RESPIRATORY SYSTEM :

ABDOMEN

NERVOUS SYSTEM :

CARDIO VASCULAR SYSTEM

1. Pulse
2. Blood pressure
3. E.C.G.

RESPIRATORY SYSTEM

1. R.R. /mit.
2. Chestexpansion Cms.
3. Breath hold time Sec.

4. T.L.C.	4. T.V.
5. D.L.C.	5. I.R.V.
6. P.C.V.	6. I.C.
7. E.S.R.	7. E.C.
8. R.B.C. Count	8. E.R.V.
9. Hb%	9. V.C.
10. Pletelet count	10. $F.E.V._1$
11. Blood sugar	11. B.M.R.
12. Blood cholesterol	12. M.B.C.
13. Blood urea	13. 0_2 Consumption
14.	14. 40 mm Press. Test